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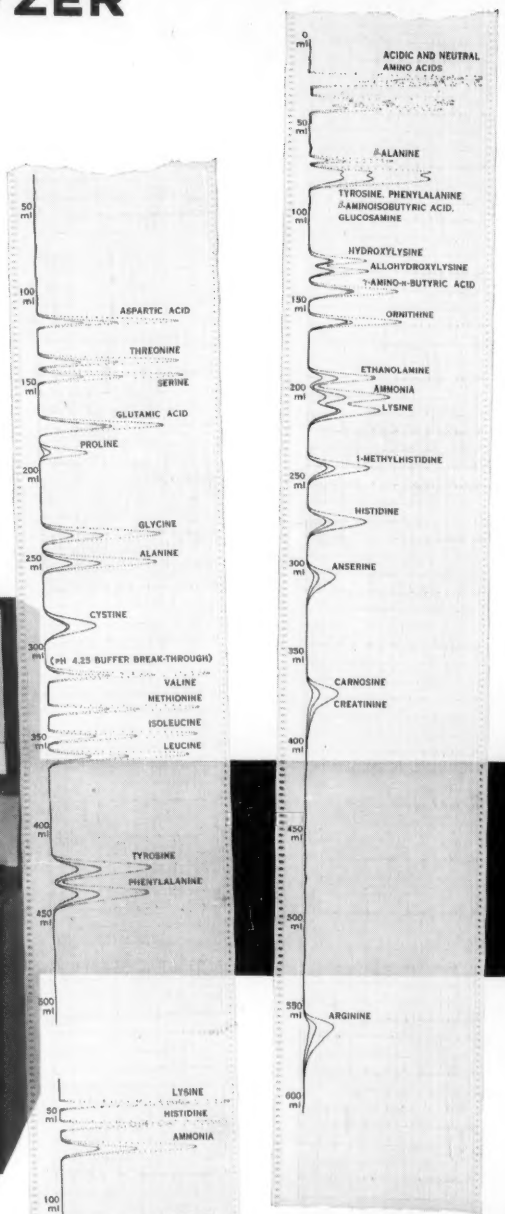


*Chart at left is analysis of amino acids found in protein hydrolyzates: top run on 150-cm column at 50°C and pH 3.25 buffer, with changeover to pH 4.25 buffer at 6 hours; lower run on 15-cm column at 50°C and pH 5.28 buffer*

*Chart at right shows components in physiological fluids: 50-cm column at 30°C and pH 4.26 buffer, with changeover to 50°C at 14 hours.*

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**Reference:** *D. H. Spackman, W. H. Stein, and S. Moore, "Automatic Recording Apparatus for use in the Chromatography of Amino Acids", Anal. Chem., 30, 1190-1206, 1958.*

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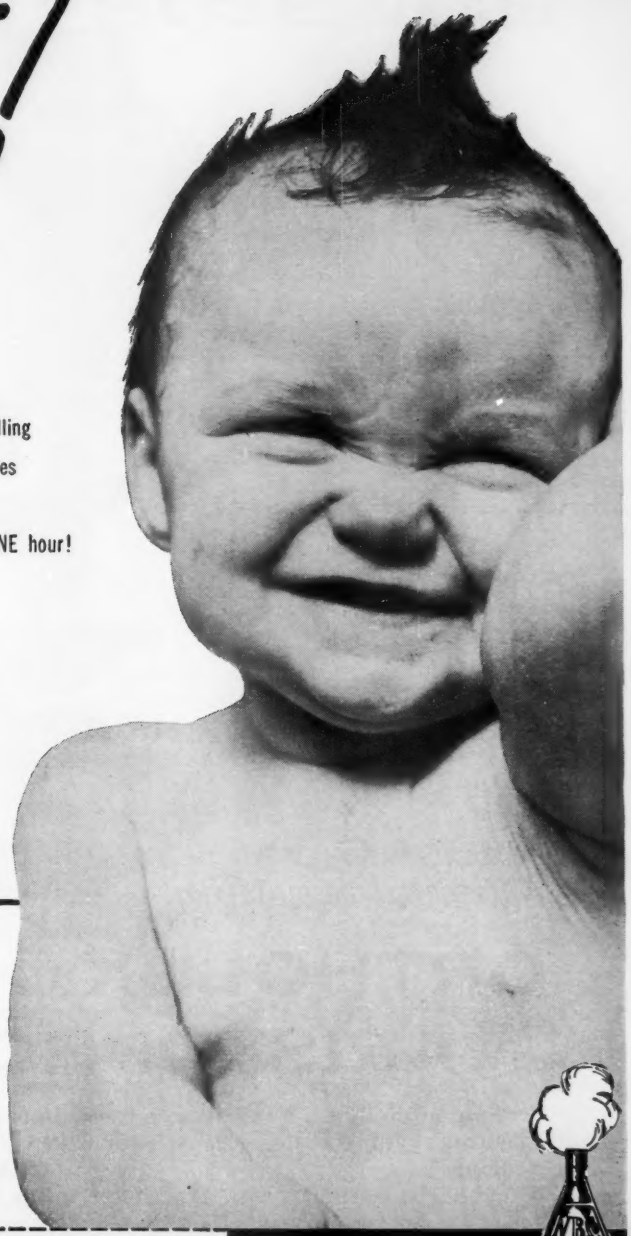

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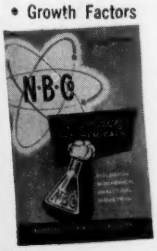


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Julian S. Huxley, noted British biologist, editor, writer, and grandson of T. H. Huxley, "Darwin's Bulldog," in the library of Charles Darwin's home at Down, Kent, England. [From "The Ladder of Life," one of the Columbia Broadcasting System's weekly television shows in the *Conquest* series]

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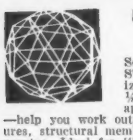

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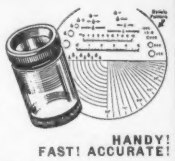

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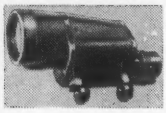

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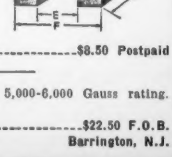


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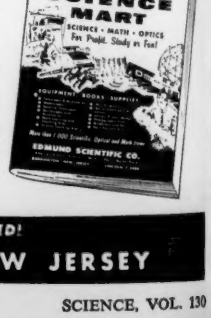


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## Cranberry Smash

The recent hullabaloo about cranberries was initiated on 9 November —"Black Monday" to the cranberry industry—when Secretary of Health, Education, and Welfare Arthur S. Flemming warned the public that a part of the current crop was contaminated by a weedkiller, aminotriazole. The announcement raised the curtain on a political drama that is variously interpreted according to the predilections or interests of the observers. One version has it that the action was an unwarranted attack by Big Government on a small industry that supplies the American housewife with a "pure, wholesome, and nutritious food." At the opposite extreme, the Secretary is pictured as a champion of public health, protecting the consumer in courageous disregard of the political consequences.

Whatever the interpretation, the surface facts are not in dispute. The product, aminotriazole, is properly registered with the Department of Agriculture as an economic poison. If it is used in cranberry bogs as directed, within a few days after harvest, and at no other time, it will not be incorporated in the berries produced the following year. But if it is used during the growing season it will be incorporated in the berries.

In 1957 the product was apparently misused by some growers, and the FDA succeeded in having 3½ million pounds of cranberries withdrawn from the market on the grounds that the berries had not been shown to be safe for human consumption. Before that, the American Cyanamid Company had asked that a tolerance for a certain amount (reportedly 1 part per million) of aminotriazole be set, but the FDA denied the petition on the grounds that tests run for the company by an independent laboratory showed the compound to be a possible carcinogen (cancer inducer).

In 1958 the company again petitioned that a tolerance be set, and the petition was again denied; no appeal was made.

Apparently few growers misused the product in 1958, and no seizures were made. In 1959, however, contaminated berries were found, first in Washington and Oregon and then in Wisconsin. Impounded lots are being tested and released as soon as they are shown to be uncontaminated.

What are the scientific issues? This question would be easier to discuss, if not to answer, if the basic facts about the compound had been made public by the FDA. As of this writing, both the petition and the scientific appraisal by FDA scientists and physicians are confidential, but it has been possible to obtain some information. The tests showed that rats fed for 2 years on a diet containing 100 parts per million of aminotriazole developed a significant number of thyroid adenomas and adenocarcinomas ("cancers"); those similarly fed at the rate of 50 parts per million developed adenomas (nonmalignant tumors) but not, according to a company spokesman, adenocarcinomas. It is a reasonable inference that the FDA disagreed with this interpretation of the results as well as with the company contention that the one rat out of a total of ten that developed an adenoma at a feeding level of 10 parts per million was not statistically significant. The company argues that the substance is not a carcinogen: it must be administered continuously over a long period of time to induce cancer; a single dose, no matter how large, is not effective.

Secretary Flemming disagrees and bases his action on the statement in the Federal Food, Drug, and Cosmetic Act which says that "no additive shall be deemed safe if it is found to induce cancer when ingested by man or animal . . ."

The scientific issues are unresolved. Whether the Secretary's position is extreme cannot be appraised until the evidence is out and expert opinion is brought to bear. One prediction is safe: some battle lines have been drawn for the next session of Congress.—G.DuS.

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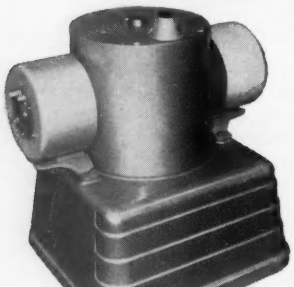

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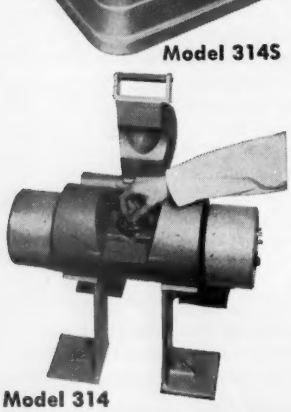

Model 314

### Manual

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# "On the Origin of Species": An Unpublished Version

## The uncompleted draft of the longer work establishes new facts about the evolution of Darwin's thought.

Robert C. Stauffer

Charles Darwin's "big book" on evolution and natural selection is still generally unknown, except for what Darwin called "my abstract"—*On the Origin of Species*—published just 100 years ago this November. The long manuscript on "Natural Selection" was already twice the length of the *Origin* and was more than two-thirds completed when Darwin's receipt of Wallace's letter outlining the same theory of evolution by natural selection interrupted Darwin's progress in writing and led to an entire change of plans for publication, involving both a reduced scale and a simplified, more popular treatment.

Writers have often indicated that the amount of writing Darwin had done on his theory before the appearance of Wallace's letter was negligible, although there is a whole chapter in Darwin's *Life and Letters* entitled "The unfinished book." It has even been suggested that, without the stimulus from Wallace, Darwin would have procrastinated indefinitely about developing in detail, and publishing, his views on evolution. This seems far from reasonable in the light of the surviving manuscripts. Although the organization of the *Origin of Species* as first published in 1859 shows improvement over the manuscript, which is only a first draft, the long manuscript version contains considerable unpublished illustrative material of great interest in so far as it enlarges our understanding of Darwin's thought. Most valuable of all for everyone interested in the history of scientific ideas is the wealth of source references in the abundant notes which Darwin was too rushed to include in the abstract published in 1859.

The fact that the manuscript has survived seems even less well known than that of its original existence, yet as *Nature* announced in the middle of World War II (*1*), it is part of the magnificent collection of Darwin's scientific papers given to the University Library, Cambridge, by the Darwin family and the Pilgrim Trust.

This long manuscript, which Darwin entitled "Natural Selection," turns out to be version 3 of Darwin's book on species. Before we examine this large-scale treatment of evolution, we might consider briefly Darwin's earlier notes and sketches on the subject. Darwin had already had extensive field experience and opportunity to study the problem of the nature of species and varieties during the voyage of the *Beagle*, in particular the fossils of the Argentine and the peculiar tortoises, finches, and mocking thrushes of the Galapagos Islands. When he had returned and was working on his collections, he recorded in his personal diary (of which there is a copy in the Darwin scientific papers at Cambridge): "In July [1837] opened first notebook on 'Transmutation of Species'—Had been greatly struck from about month of previous March on character of S. American fossils—& species on Galapagos Archipelago.—These facts origin (especially latter) of all my views." Fifteen months later Darwin conceived his theory of natural selection as a mechanism of evolution when his reading of Malthus' "Essay on Population" reminded him of Lyell's discussion of population pressure and the struggle for existence. Early in the summer of 1842 he wrote out, in pencil, a sketch of his species theory in 35 pages. This was version 1. Two years later he expanded this to a draft of 230 manuscript pages. This version 2 was completed by July 1844. (These two earliest versions were edited by Francis Darwin and published by the Cambridge University Press in 1909 as the *Foundations of the Origin of Species*.)

### Fear of Premature Publication

By this time Darwin was so convinced of the importance of his theory that he wrote out instructions that in case of his premature death version 2 should be published, and he directed that £400 or £500 be used for this purpose. But 1844 was the year in which the provocative and debatable *Vestiges of Creation* was first published. This bold popular speculation on the theme of evolution, with its amateurish blemishes and occasional crude errors of scientific fact, aroused hostile criticism among most English natural scientists. Darwin took this as clear warning of the dangers that would attend any premature or incompletely substantiated presentation of his own theory of evolution. This must have reinforced the caution about speculation on evolution with which Darwin had already been indoctrinated through his study of Lyell's exhaustive criticisms of Lamarck in the *Principles*. Darwin was not afraid

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of speculation as such, and he remarked: "I am a firm believer that without speculation there is no good and original observation." (*2*), but he had every reason to wish for his theory the unprejudiced consideration which could only be won by abundant new evidence carefully presented. A man of private means, he could afford to bide his time until his reputation was established as an able naturalist and a competent taxonomist, and until his evidence had mounted to such overwhelming proportions that his theory could not be dismissed or ignored so easily as those of Lamarck and Chambers had been.

By the middle 1850's the time was ripe. Darwin had been awarded the Royal Society medal in 1853 when his reclassification of the barnacles began to be appreciated. He had been on the council of the Geological Society for a dozen years and on the council of the Royal Society for several years. His *Journal of Research* of the *Beagle* voyage had gone into a second popular edition. He had supervised the publication of the zoology of the *Beagle* voyage in five volumes and had published three volumes of his own on the geology of the voyage. He had mastered the obscure anatomy and had reorganized the classification of a whole complicated order of invertebrates, in four extensive monographs on the barnacles, both fossil and recent. Besides these eight books, he had published several dozen articles on geology and zoology in scientific journals. He had already done much to justify the prediction which the Cambridge geology professor, Adam Sedgwick, had made when Darwin was still in South America, that "if God spares his life he will have a great name among the naturalists of Europe" (*3*).

## Preparation of the Manuscript

When his taxonomic work was completed, Darwin was ready to resume intensive work on the species problem. He had read "whole series of journals and transactions," gleaning facts and taking notes until, in the summer of 1854 when he was finishing his long study of the barnacles, he wrote that his notes on evolution were of such bulk that "I cannot possibly lay my hands on any reference" (*4*). And so, on 9 September, he recorded in his pocket diary: "Began sorting notes for my species theory." When visiting the Wedgwoods at Maer in Staffordshire, he made careful observations of the effects of planting larch and Scotch fir on the balance of vegetation on the heath and noted the accompanying changes in insect and bird populations. To become familiar with variation under domestication, he kept every breed of pigeon he could obtain, associated with several eminent fanciers, and joined two of the London pigeon clubs. He sent out questions in all directions to correspondents who might supply facts useful for his work. He discussed his views with close friends, like Lyell, who urged early in 1856 that Darwin consider himself ready to start writing. Beginning his draft in May 1856, he soon found himself working on a large scale, "yet it was only an abstract of the materials I had collected" (*5*). Thereafter, with almost every chapter, he recorded the dates of his progress in his pocket diary.

Darwin's prudence about premature publication did not stand in the way of his writing friends about his belief that "species are not immutable." He had written this as early as January 1844 to Joseph Dalton Hooker, the botanist, and he also shared his views with Leonard Jenyns (later Blomefield), Charles Lyell, and Asa Gray. In his letter of 1 May, 1857 to Alfred Russel Wallace (*6*), he mentioned that for 20 years he had been collecting material on how "species and varieties differ," and that he had already written "many chapters" of his book. Thus, Wallace had a general knowledge of Darwin's interest in the species question, and it was not mere chance that led him to send Darwin his sketch of his own theory of natural selection early in 1858.

With the unwanted interruption occasioned by the receipt of Wallace's paper, which seemed almost like a précis of his own views, Darwin soon felt obliged to set aside his work on version 3 in order to write an abstract of his long manuscript which could be published without long delay. The abstract, version 4, he completed in eight months, and it was published in late November 1859 as the first edition of *On the Origin of Species.*

## Unfinished Version

But what had Darwin accomplished in version 3, the form in which he had planned to present his theory? He had written 125,000 to 130,000 words. He had completed 11 chapters, covering about 70 percent of the topics which were treated in the published book. The order of these chapters differs slightly from that of version 4. The first two chapters cover in detail "Variation under domestication." Chapter 3 is "on the possibility of all organic beings occasionally crossing and on the remarkable susceptibility of the reproductive system to external agencies." Chapter 4 is on variation under nature. Chapter 5 is on "the struggle for existence as bearing on natural selection." Chapter 6 is titled, "On natural selection"; chapter 7, "Laws of variation: Varieties and species compared"; chapter 8, "Difficulties in the theory of natural selection in relation to passages from form to form"; chapter 9, "Hybridism"; and chapter 10, "Mental powers and instincts of animals." Finally there is an unnumbered chapter on geographical distribution. Thus, for only four of the 14 chapters that later appeared in the published version were drafts lacking.

The manuscript for all but the first two chapters of version 3 survives. The manuscript for these was presumably used in the course of Darwin's writing of his later book on the same subject, his *Variation of Animals and Plants under Domestication,* published in January 1868. But Darwin wrote out a full table of contents for the ten numbered chapters of his manuscript, so we have a good idea of the topics covered in the missing portions.

Parts of the chapter on instinct from version 3 were published in two books by George J. Romanes, *Animal Intelligence* (London, 1882), and *Mental Evolution in Animals—With a Posthumous Essay on Instinct by Charles Darwin* (London, 1883). The rest of the manuscript deserves further study. Darwin's handwriting is so difficult to decipher that such a study can best be made after the manuscript has been copied in full. I have transcribed and edited chapter 5, on the struggle for existence, which I hope to publish soon, and am now working on the rest of the transcription.

## Darwin and Linnaeus

Initially I was interested in the manuscript because of the new light it throws on the development of Darwin's ideas on ecology. The ecological problems of adaptation, and of the relations of plants and animals to each other and to their environment led Darwin to have a deep interest in the "economy of nature"

Darwin at the age of 40. From a charcoal drawing. [Courtesy of the Smithsonian Institution]

as the setting for the struggle for existence and for natural selection. Here the manuscript offers new illustrative details. Moreover, it makes clear the prime influence of Linnaean essays such as the "Oeconomy of Nature," the "Police of Nature," "On the Increase of the Habitable Earth," "The Flora of Insects," and the "Swedish Pan." Darwin studied all of these and more in English translations, dug out many useful facts and ideas, and cited them in the notes of his manuscript chapters.

Thus we are led to a paradox. The conventional view is that Darwin overthrew the work of Linnaeus in so far as he replaced the orthodox dogma of fixity of species by his theory of evolution. But in regard to Linnaeus' ecological concepts of an economy of nature, Darwin used these ideas as major explanations of the working of natural selection. So Linnaeus was of major assistance to Darwin in the latter's formulation of his theory of evolution.

In conclusion, what can be said about the implications of Darwin's "Natural Selection"? It is tempting to speculate as to the historical outcome if Darwin had been left undisturbed and free to publish his theory in the form he originally planned. It would have been a detailed two-volume work with full documentation, appealing to an audience of specialists but probably not to a wider public. It might even have been ignored by Bishop Wilberforce and by other hostile critics in some of the great literary review journals. *Darwinism* might have been less subject to misuse by would-be scientific supporters of laissez-faire economy and of imperialism. Darwin himself, instead of having to devote months to frequent revision and qualification of the *Origin of Species*, for five more editions, might have been free to develop more extensively the concept of the economy of nature as a background for the struggle for existence, and to carry out the plan mentioned in 1859 in the *Origin of Species* in regard to the latter subject: "In my future work this subject shall be treated as it well deserves, at much greater length." In the late 19th century there might have been less "Social Darwinism" and more ecology (*7*).

#### References and Notes


1. *Nature* **150**, 535 (1942).
2. C. Darwin, in a letter to Wallace, 22 Dec. 1857.
3. S. Butler, Ed., *The Life and Letters of Dr. Samuel Butler*, vol. 2, p. 144 [volume 11 of S. Butler, *Works*, H. F. Jones, Ed. (London, 1924)].
4. Letter to Hooker, July 1854 (letter No. 36 in *More Letters*).
5. C. Darwin, *Autobiography*, N. Barlow, Ed., (London, 1958), p. 121.
6. F. Darwin, Ed., *Life and Letters of Charles Darwin* (London, 1888), vol. 2, p. 95.


7. The research for this article was made possible by research leave and travel funds for 1957 granted by the Graduate School Research Committee of the University of Wisconsin and supplemented for 1958 by a travel grant from the American Philosophical Society. I wish to thank the Cambridge University library for granting me permission to have Charles Darwin's long manuscript version of the *Origin of Species* microfilmed, and H. R. Creswick, university librarian, and Mr. Gautrey of the Anderson Room for their hospitable assistance.


# Darwin or Spencer?

## Why has Darwin's reputation risen, while that of Herbert Spencer has declined?


George Kimball Plochmann


The writings of Herbert Spencer, formerly so influential, now line the back shelves of second-hand bookstores. Yet the chief books of Darwin are forever being republished and are so much read that their author's name is virtually a synonym among ordinary folk for "evolution," and among sophisticates for "natural selection." I am speaking, of course, about the way these men are received now, in the 20th century; in his own day, which was that of Darwin too, Spencer was regarded as a giant, and his *Principles of Biology* was adduced as one of the chief evidences for this high estimation. Of course this could not be on literary grounds; Spencer is no more a first-class stylist than Darwin, and it must have been content and general arrangement rather than any niceties of diction that kept readers faithful through his dozen volumes, so stuffy in their confidence, so heavy in their repetitions and summaries. But then, there is also *The Origin of Species*, winding in its periodic sentences, replete with modifiers, disclaimers, and exceptions.

Had Darwin and Spencer been more tendentious men, they would doubtless have become embroiled in Newton-Leibniz disputes regarding priorities; as it was, both writers were eminently fair and shared with each other and with Alfred Russel Wallace their findings, hypotheses, and honors. It would be difficult to establish the interlocking priorities here: Spencer's preliminary essays were published some time before *The Origin of Species*, yet the definitive statement of his biological views was printed a dozen or so years after (*1*). For this reason it should be the implications of the theories, rather than their order in time, that concern us here. And for all these reasons, it is not my intention to trace the course of biologic history in the past hundred years to account for the disproportion in the respective influences of these outwardly rather similar thinkers. Rather shall I suggest a number of methodological and conceptual reasons why one man has been in good part forgotten, the other raised to such an elevation.


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### Principles and Their Extension

Spencer's *Principles of Synthetic Philosophy* begins with a kind of metaphysic of nature, then passes through biological principles, psychological, sociological, and ethical. Within the volume *First Principles*, Spencer exhibits the applications of each principle, with a glance at convenient facts in each of the sciences he is later to develop at length, thereby clarifying but neither proving nor intending to prove his primary generalizations. The account in the *Principles of Biology* follows a

fixed order: first the physicochemical principles and particulars, then a discussion of their effects in biology. So the construction of the biology mirrors that of synthetic philosophy as a whole. For Darwin, this movement from physics to biology is not in question.

In Spencer's biology there are a vast number of topics tied to the general laws of evolution, illustrative of them, and interpreted by them alone. However, the formula of evolution is first reached not in the *Biology* but in *First Principles* (*2*), and is held to be quite universal in application. In the biological treatise, therefore, Spencer is able to take his principle wholly for granted, a procedure by the way just the reverse of Charles Darwin's, for the latter takes endless pains to establish one. So Spencer needs merely to pass from the "data" (which are not at all the raw facts, but what is "given" to biology by physical chemistry) to biological "inductions"—namely, the topics of growth, development, structure, function, adaptation, heredity, variation, and so on, of *living* things, not things in general. A third section of Spencer's book examines the formula of evolution as it gives meaning to biological phenomena and elaborates the arguments, drawn from the earlier topics, in favor of this second application of evolution to simple living forms. Development, both morphological and physiological, is next, the treatise then being brought to a close with the laws of multiplication of individuals and of species.

In Spencer's metaphysic of nature, forces and their resultants work as well upon the solar system as upon the universe as a whole, upon the burning of a candle and the melting of ice, and upon molecular alterations. Spencer conceives this to be part of the great strength of his theory—its immediate and universal applicability. Nature is always and everywhere the same. No doubt this view has cost Spencer many followers, who are unwilling to base their biology upon such simple physics. For example, in organic growth, Spencer holds that the line of movement is the resultant of tractive and resistant forces (*3*, pp. 233, 234; *4*). Where both attractive and repulsive forces are appreciable, movement takes place along the resultant of *all* the tractions and resistances (*3*, p. 225). So in this respect it is impossible to say anything about plants which you cannot say about bricks also. It is not that Spencer favors mechanism over vitalism, but that his mechanism is so crude (*5*).

## Life and Matter

I find nothing parallel to Spencer's broad extension of principles in Darwin—at least nothing systematic. For Darwin, biology has its own proper topics, methods of inquiry, conclusions. *The Origin of Species* is steadfast in its refusal to draw upon mathematics, physics, chemistry—indeed upon anything outside of biology except the socioeconomic theory of Malthus. For Darwin the relation of part and whole, one of the key notions in his whole theory, is conceived in uniquely organic terms; and so also are the ideas connected with alteration, life, specific characters, motion, and so forth (*6*). The chapters which occupy the middle portion of his book are on geology, true enough. But they too are conscious importations of geological subject matter into the account, importations which are packaged and sealed against contamination by principles relating to organic life (*7*). Geology, for Darwin, explains ecological distribution and the facts of paleontologic placement by its *findings* but does not lend its resources to answering such questions as: What is an animal? What are animal species? What does it mean to say that species have an origin and development?

For Spencer, however, the parts of living bodies arrange themselves in virtue of certain movements of their own, though the forces proper to living aggregates are derived from kinds of physical energy found throughout all nature—energy types such as heat and light, which are the primary conditions, according to Spencer, of growth (*3*, p. 210). He talks of a community and exchange of energy between inanimate and animate, the latter receiving its working supply from the former. Some of the components of organic matter are gases, and in their uncombined states these gases have so much molecular motion that they are incondensable. Thus, the essential characteristic of living matter is that it unites much of its contained motion with a degree of cohesion sufficient for a temporary fixity of arrangement (*3*, p. 300). Thus, living matter differs from nonliving in degree, not kind. This, I believe, is primarily a consequence of the fact that Spencer no longer thinks mainly of the individual substance as being alive, but of matter of a certain kind as having life, as being actually alive. In Aristotle, and in much the same fashion in Darwin, the composite substance is the main thing; Aristotle even says that the matter is no more than a possibility of the life and the substance (*8*). For Spencer, matter here is as good as matter there, so long as it shares the common properties of motion and coherence (*9*). Only metabolic changes can be really considered as vital—that is, nutritive activities and growth—for such changes are characteristic of protoplasm only (*4*, pp. 42*e*-43*a*, 69*b* ff.). Again we move away from Darwin; not only is matter alive, but it is in terms of matter that we determine the essential characters of life, not in terms of motion (as in Plato) (*10*), or a complex of biological functions (as in Aristotle), or intellection (as in Hegel). Spencer takes the hypothesis of evolution, which allows us to assume that the first units of protoplasm could appropriate directly from the inorganic world both the nitrogen and the materials for carbohydrates without which protoplasm cannot be formed (*4*, pp. 63-64; *11*). Others might object that this is no real explanation, that it merely sets back the difficulty one more step in time. What it comes to is that for Spencer life is definable in terms of that matter which evolves, and evolution is not definable strictly in terms of things living.

## Origin of Alterable Characters

The title of Darwin's book, on the other hand, is an indication that he takes life and its peculiarities pretty well for granted and is content to look for the origin of species, or what he might better call the origin of alterable characters, inasmuch as the species as an inflexible class largely disappears from his work (*12*). His book is a massive effort to apply two-part distinctions over the whole field of what he regards as strictly biological change. His first and major division is between domestic selection and natural agencies—between weak and external agencies, producing alterations, and strong and internal ones. The weaker, domestic agencies have two subagencies, those kinds that tend to cause variation and those that promote endurance of the variations (*13*). Of the causes of variability there are four, of which two—changed conditions of life and the law of use and disuse—are the most significant. Changed conditions of life, again, are of two kinds, direct and indirect, the direct are of two subtypes, and so forth. Darwin admits that reasoning from domestic selection to natural is an analogy but points out that animals in the pen and

in the wild must struggle alike for their existence. Natural agencies are again two: the general selection that permits only the fittest to survive, and so-called sexual selection, which operates to much the same effect. Natural selection operates on both new and old forms, bringing about adaptation and divergence of the former, preservation or destruction of the latter. Such, in outline, is the set of distinctions which Darwin employs—contrary terms drawn from the language of ecology and genetics (*14*). It is with these that he frames the idea of evolution, which has been in the history of science primarily a biological one, as Darwin understood biology. Spencer, for his part, takes evolution from biology, then strips it in good part of its biological character, as in his famous jawbreaking formula for evolution, which is pure physics (*15*).

Spencer now hazards several definitions of life, each one taking care of the two functions farthest apart in the scale—namely, assimilation and reasoning (*4*, vol. 1, p. 81). He is best pleased with the definition of life as the continuous adjustment of internal relations to external relations (*4*, vol. 1, p. 99). In other words, it is a series of reciprocal and complex adjustments; yet the explanation of each adjustment referred to is sought in physicochemical forces—up to the point where we reach the Unknowable (*16*). The adjustment is thus mechanical—the reaction to incident forces impinging upon the organism.

At this point Spencer's analysis admittedly breaks down; life is an unspecified principle of activity, since life cannot be conceived, as he reluctantly admits, in purely physicochemical terms, and yet the hypothesis of a vital principle, he is quick to add, is equally unsound (*4*, vol. 1, pp. 114-115, 120). The ultimate behind all living manifestations is incognizable. All he can say with assurance is that as the parts continue to function and integration increases, languor supervenes, since the motions of the parts require more energy, temporarily, than the parts or the whole of the organism are able to supply from the material absorbed as nutriment. This is the equilibrium that always supersedes evolution; evolution, in Spencer's mind, always aims at some medium or mean, and the excesses or deficiencies are quickly removed—by the process of evolution itself. Darwin, of course, asserts that species lose the function of organs through disuse, but this is quite incidental, and there is no reason to insist categorically that it is bound to occur—it is contingent upon the accidents of changed environment.

### The Evolutionary Principle

Spencer seems not to have studied Darwin very thoroughly (*17*), but he comes closest to him as he passes from evolution within the animal to what the biologist ordinarily tries to signify by the term *evolution*: the historical development of morphologic traits, and the consequent origination of new species. Spencer's procedure here is to assume that progressive speciation (not accepted in his time by an imposing number of leading biologists) is the best instance of the more general phenomenon of evolution. He is *not* proving that the universe evolves because a great animal evolves (Whitehead), or that the universe is animate (Plato), or that animals are no more than mechanisms (although that sometimes appears to be his contention). It is Spencer's point, rather, that organic "evolution" as Darwin conceived it is one more example of a phenomenon rooted in the distribution of forces. Darwin was concerned with the total biological adjustment, considered as a complex, not a set of forces; Spencer, with the effects of discrete causes upon parts. Of course, it is difficult to see how the *parts* of biological environment could be anything but physical forces, so we must admit that Spencer is not obviously mistaken.

After noting that the evolutionary principle explains important subtopics of organic speciation, such as the resemblances of embryos to the body plans of phylogenetic forebears, and such as homologues, vestiges, and the like, Spencer next comes to grips with the modifications of species themselves (*3*, pp. 418-419). He notes, in many parallels to Darwin, that such groups are modified with respect to growth and functions, and that their modifications in turn produce new functions. Unlike Darwin, he barely raises the question, "What is a species?" but assumes that the animals of a single species will follow the same general reactions to varying forces in their environment. Yet species do become divergent, by the subjection of their members to unlike sets of circumstances (*3*, p. 419). The individuals are not *quite* similar, and the first differences are the occasion for further differentiations. Thus, modifications of species, like the modifications of organs during embryonic growth, are brought about by aggregates of external forces. Here Spencer almost ignores one of the questions most troubling to Darwin, for whom a species is not so much a type as a population, parts of which may be altered while the rest remains nearly the same (*18*, pp. 38, 373). How is it, Darwin wonders, that some species remain homogeneous while others break up into several varieties (*19*)? It should be noted that the species type, like the organic form, is only hinted at by Spencer in a vague way, and no further allowance is made for it in biology or the metaphysic of nature. We have previously noted that the species are produced as the "fixities"—whatever that may mean—of the natural organic process. Thus nature, for Spencer, seems to be outside the living species; and it is that which shapes them, being the forces incident to them. This is quite analogous to the proposition about individuals: Vitality is not a principle of the natural unity of the organism. The individual organism evolves, but not through an internal nature (*3*, p. 447).

For Spencer as for Darwin, survival of the fittest is the best explanation for natural selection; in the *Principles of Biology* it amounts to nothing more than dynamic equilibrium of functions in the presence of forces outside—that is, those creatures which do survive are able to adjust to the changes in the environment quickly and completely enough to maintain their internal stability; they have, not an evolution or a dissolution, but an equilibrium toward which their evolution has led them. In the *Origin of Species*, on the other hand, survival represents the interactions of chance and necessity within a living population which may be better adapted than other living creatures to the circumstances at hand (*20*).

### Methods

Darwin has a single, all-embracing analysis of biological evolutionary phenomena (he turned to the problem of human descent in a separate book not because it was intrinsically a different problem but because of tactical considerations). In like fashion, Spencer uses one procedure throughout *First Principles* and, with little alteration, throughout *Principles of Biology*. In its

main outlines and applications, his method is quite simple: an inductive-deductive cycle. Induction leads always from instances to a general truth; deduction, from a general truth to instances; and for reasons of exposition Spencer uses the two methods side by side, in nearly every chapter. However, the meaning of *instance* changes in the two methods: in induction, the instances are familiar, well-received examples founded upon observation, which lead to propositions about the general character of evolution or life. In deduction, the general truth from which all knowledge starts is the persistence of force, and the instances derived are only less general; they do not yet relate to particular examples. There is thus a rhythm of induction and deduction, which makes an arbitrary starting-point of the concept of force, just this side of the Unknowable. But the rhythm is incomplete, and though the inductions begin with matters of observation, the deductions do not end there. For Darwin, on the other hand, there is a simpler method: One begins with vast catalogs of facts (catalogs which he regrets he is unable to print in full in the *Origin of Species*) (see *18*, p. 82), and one proceeds directly to the most convenient inductions regarding them. The entire method is an attempt to confirm a leading hypothesis and its corollary supposals (*21*).

In Spencer, there is an immediate relation between general principle and uninterpreted fact. A theory can be upset by a fact, a definition can be shown, in the light of facts, *the* facts, to be deficient (*4*, vol. 1, p. 111). Yet we can accept a definition—of life, say—as it stands, while at the same time restricting its scope of application. Now a definition amounts, in Spencer, to a generalization or hypothesis; hence, the same kinds of facts can be used to support a definition and to support a hypothesis. The definition or formula of evolution, furthermore, is at the same time a law, which stands or falls on instances (*4*, vol. 1, p. 437). Thus, in his physical and biological method, Spencer reduces everything to the same level of intelligibility, priority, necessity, and truth.

But for Darwin, definitions are hardly on the same footing with other types of assertion. Gone is the machinery for showing that a definition *must* hold, and instead we have the rather limp admission that a species is whatever the experts want to think it is—and other statements to more or less the same effect.

Spencer seems happiest in his method when he begins with least parts or simple parts and builds them into compounds, and complexes of compounds, by integration (which simultaneously produces differentiation). This integrative method is not quite simple addition, since the whole reacts to external stresses somewhat differently from the way its original elements did but the new reactions are resultants of the old and may, so to speak, be mechanically defined and computed. Evolution is conceived by Spencer as a route from simplicity to complexity, life in one sense being a complex result of the process; in another sense, the cause of further complication. For Darwin, nothing is a simple part, and his method seeks to locate casual factors in an already functional whole. Evolution he limits to groups of animals, making little attempt to find a likeness between the growth of the individual and that of the genealogical "tree" (*22*).

## Conclusion

We have seen that Spencer's approach to every biological problem is to seek for characteristics applying to the inorganic, or to both the organic and inorganic together. But to designate these characteristics he sometimes uses terms drawn from biology narrowly conceived and then extends the application of these terms to the whole physical world; and sometimes he does the same with physical terms (*23*). The result is the confusions in terminology, subject matter, and scientific method that I have enumerated. It is my conclusion that these confusions, rather than questions of biological expertness or matters of detail, account for the discrepancies in the positions of the two men in the history of science, viewed from the standpoint of today. I suppose one could make a good case for the contention that Spencer has anticipated about as many latter-day theories relating to evolution as has Darwin (*24*), but this still does not seem to entitle him to a place of first importance in the history of science. It is not the fact that Spencer espoused some pre-Darwinian ideas, Lamarckian in origin (*25*), that has relegated him to the side lines, for many pages of Darwin himself wear a very old-fashioned look. It is rather, I think, that the biologist fears that he would have to adopt a whole stack of mediocre physical concepts along with some quite interesting botanical and zoological explanations were he to accept Herbert Spencer, whereas Darwin leaves him freer to pick and choose physical, mathematical, and chemical explanations more in accord with 20th-century ways of thinking, because of a cautious silence concerning them.

### References and Notes


1. A few dates would be helpful here. Darwin's accounts of his voyages were published in 1832, 1839, and 1845. His geological conclusions, gained from observations while on the *Beagle*, were first printed in 1842, and more were added in 1844 and 1846. Spencer envisaged the problem of change in a book published in 1850, *Social Statics*. At a time Darwin wrote a whole series of highly detailed papers on insects and on geology, Spencer was writing his "The Development Hypothesis" and "The Theory of Population" (1852) and his *The Principles of Psychology* (1855), which became, in somewhat altered form, a part of his great work on synthetic philosophy. The joint work of Darwin and Wallace was put before a not wholly alert scientific public in 1858, and the following year saw the first of six editions of *The Origin of Species*. *First Principles* appeared in 1862, and it likewise had gone through six editions by 1900. In 1864 Spencer began publication of his *The Principles of Biology*, and 4 years later Darwin issued the two volumes of *The Variation of Animals and Plants under Domestication*.
2. "Evolution is an integration of matter and concomitant dissipation of motion, during which the matter passes from an indefinite, incoherent homogeneity to a definite, coherent, heterogeneity; and during which the retained motion undergoes a parallel transformation" [*First Principles* (Appleton, New York, 1892), p. 367]. We are reminded of the simplification by which William James came close to parodying this definition: "Evolution is a change fom a no-howish untalkaboutable all-alikeness to a somehowish and in general talkaboutable not-all-alikeness by continuous sticktogetherations and something-elseifications" [R. B. Perry, *The Thought and Character of William James* (Little, Brown, Boston, 1935), vol. 1, p. 482].
3. H. Spencer, *First Principles* (Appleton, New York, 1892).
4. ———, *Principles of Biology* (Appleton, New York, rev. ed., 1904).
5. A much better version of the mechanics of growth, showing the interaction of multitudes of heterogeneous forces, is to be found in D'Arcy W. Thompson's brilliant studies. "D'Arcy Thompson: His conception of the living body" [*Phil. Sci.* **20**, No. 2 (1953)], an essay of my own, presents some of the methodological problems in a brief compass for those not familiar with the great *On Growth and Form* (Cambridge Univ. Press, New York, 1942).
6. I even find very little reference in *The Origin of Species* to *evolution* as a separate term. But see pages 99-100 of that work [C. Darwin, *The Origin of Species* (Modern Library, New York)].
7. I refer to chapters 10 and 11 of *The Origin of Species*. Geography is put to the same kind of use in chapters 12 and 13. The edition to which page references are given here is a Modern Library "Giant," which reprints the sixth edition of 1872.
8. See my "Nature and the living thing in Aristotle's biology" [*J. Hist. Ideas* **14**, 167 (1953)] for a general review of that theory.
9. I have often wondered why Spencer, who foreshadows a number of the tenets of physicalism, has been little read and appreciated by the positivists, who have instead turned their attention to Hume, one of Spencer's own sources.
10. The first third of the discourse by Timaeus in the dialogue bearing his name is an account

which links motion with the life of the heavens.

11. Spencer effectively raises questions which have recently been treated under the head of proto-evolution, or chemical evolution. See also A. I. Oparin, *The Origin of Life* (Dover, New York, 1953), especially chapter 1. Geneticists, organic chemists, and physiologists are all converging upon this problem of what happens to simple salts, metals, and so on to make them capable of self-transformation so that they can sustain life processes.
12. This is not quite an innovation of Darwin's. See, for example, M. Mandelbaum, "The scientific background of evolutionary theory in biology" [*J. Hist. Ideas* **17**, 345 (1957)]. Much remains to be done to find out whether, for Aristotle himself, species are fixed in the sense that Darwin denied that they are. Before an answer could be given, one would need to master a great deal in Aristotle's metaphysics, logic of science, and physics, as well as his biology.
13. See E. Rádl, *The History of Biological Theories* (Oxford Univ. Press, London, 1930). On pages 63 and 64 Rádl seems to hedge on whether Darwin gives more descriptive or more causal accounts of variation. Rádl ought to be altered to read "causal," without question. This opinionated and often fuzzy book should be read for the valuable leads it gives into material not ordinarily examined nowadays.
14. Most of these distinctions are made in the first four chapters of *The Origin of Species*, and many are summarized in the final recapitulation.
15. Rádl goes even further when he says (*The History of Biological Theories*, p. 71): "It is true that Spencer did pursue definite biological studies, but these hardly bore any relationship to the substance of his explanations—and his explanations far exceeded the range of his observations, both in quantity and in quality."
16. Spencer himself says (*First Principles*, chap. 1) that the analysis of many phenomena can go only so far before it ends in contradiction or an unanswerable question. For Bradley's neat reply to this, see *Appearance and Reality* (Clarendon Press, Oxford, 1930), p. 111, footnote.
17. For a compact account (taken from the *Autobiography*, mainly) of Spencer's education and of his principal doctrines, see W. Durant, *The Story of Philosophy* (Simon and Schuster, New York, 1929), chap. 8.
18. C. Darwin, *The Origin of Species* (Modern Library, New York).
19. The laws of variation are given in *The Origin of Species* (chap. 5, summarized on p. 122).
20. A grain in the balance, says Darwin (*The Origin of Species*, p. 359) determines which individuals, and even which species, shall survive.
21. The last chapter of *The Origin of Species*, entitled "Recapitulation," gives in striking form the evidence of observations throwing light upon the hypothesis and its attendent objections.
22. The "tree" appears on pages 99-100 of *The Origin of Species*, but not in connection with growth of individuals, only of groups.
23. Of course, this is not so old-fashioned as it may seem. William King Gregory, in the text volume of his comprehensive *Evolution Emerging: A Survey of Changing Patterns from Primeval Life to Man* (Macmillan, New York, 1951), differentiates what he calls polyisomeres and anisomeres in terms that would apply just as well to cosmic phenomena as they do to the invertebrates and vertebrates.
24. One excellent summary of the contributions of Darwin was contained in a public lecture delivered at Southern Illinois University by Alfred E. Emerson, 1 Oct. 1958. The lecture was entitled "The Impact of Darwin on Biology," and its author, the well-known ecologist and zoologist from the University of Chicago, presented a comprehensive list of ideas that were enunciated by Darwin but more fully elaborated by his successors. Among those foretastes of later evolutionary theory which Emerson located in *The Origin of Species* are the following: latency of genetic characters, spontaneous variability (mutations), heterosis, palingenesis, recapitulation, and homeostasis. Nowhere was it asserted by Emerson that these notions all originated with Darwin, but certainly Darwin gave them clearer voice than did most of his predecessors or even his contemporaries.
25. See Spencer's essay "Progress" for the admission that he derived a number of ideas on evolution from Lamarck. However, most of the *Principles of Biology* is neutral as regards the inheritance of characters acquired through practice.

# Introducing Industry in Peasant Societies

## Modern industrial production need not drastically disturb local ways of life.

Manning Nash

In the Malay Archipelago, in China, in Africa, and in India the spread of industrial technology and factory production methods has destroyed many aspects of native cultures. Many thinkers have come to regard such destruction as inevitable. Social scientists in particular have almost taken it for granted that industrialization sets up a chain of social and cultural events that sunders the social fabric of peasant and primitive societies. There is evidence, however, that under proper conditions an indigenous, non-Western community can adjust to factory production and still maintain the main features of its own special way of life. A case in point is the coexistence of a textile factory and a peasant society in Cantel, an Indian community located 200 kilometers west of Guatemala City in the Guatemala highlands. The factory was established some 70 years ago and employs about one quarter of the population. Cantel has the same family structure, the same role in the regional market, the same roster of saints, the same notions of law and justice, the same basis for status and prestige, and the same quality of social life that it had before the factory was established. Cantel is like the neighboring Indian communities in all respects except that among the economic opportunities that it offers is a wage job at a factory.

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### Cantel and Its Neighbors

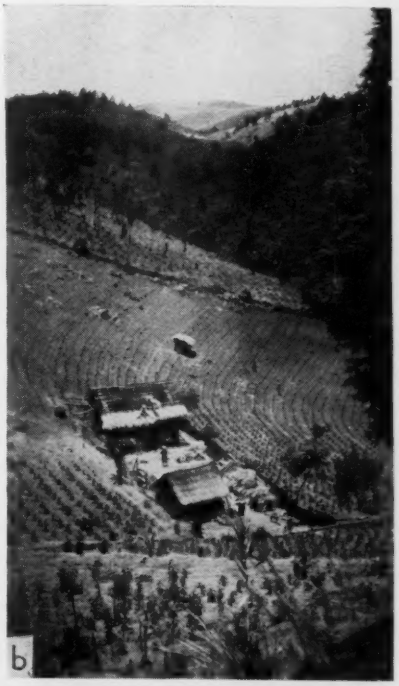
The cultural pattern of the Indian communities in the western highlands of Guatemala reflects a blend of Spanish-Indian influences, more or less stabilized in the region some 400 years ago. The chief features of the pattern are a simple farming technology, without the plow or machine tools (Fig. 1); a low level of wealth, without class lines; a political organization, tied to a religion with a hierarchy of saints; and a system of markets based on local specialization. Each community in the western highlands has some economic specialty. Markets are held in different communities on different days of the week (Fig. 2); people bring their goods to sell, and buy the things they need. The village markets are held in conjunction with central markets held daily in the larger towns.

Witches, spirits, mountain demons, and the personification of many aspects of nature are all part of the culture and world view, as is the use of the old 260-day Maya divinatory calendar.

These Indian societies, while sharing a single broad cultural pattern, vary endlessly in dialect, costume, economic specialty, roster of saints, and sacred ceremonies and even in the physical appearance of their members. Each of the Indian societies is a locally organized culture, distinct from its neighbors in fact and in its own view, and each is made up of a "people" who

have long intermarried and who feel themselves to be an ethnic group with particular characteristics and virtues.

Cantel is a *municipio*, the administrative unit of Guatemala, similar to our township. Within the *municipio* are several settlement patterns. There is a *pueblo*, which also bears the name Cantel. This town center is the administrative, religious, economic, and festal headquarters of the community. Of the community's more than 8000 inhabitants, slightly over 1900 live in the town center. The rest of the population lives in the rural *cantones*, which



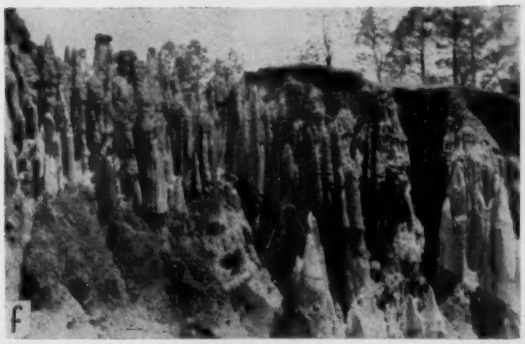



Fig. 1. (*a*) Clearing high bunch grass with a hoe in the Cuchumatanes Mountains of western Guatemala. (*b*) A cornfield and rural dwellings near Momostenango, Guatemala; the small structure in the center of the field is a shelter for lookouts, to be occupied when the corn is ripe. (*c*) Digging furrows 18 inches deep on a hillside, for planting corn. (*d*) Ears of eight species of maize from the Santa Cruz region. (*e*) Head of a deep ravine with old furrows of a wheat field at the ground surface, and (*f*) pinnacles some 60 feet high, which develop in these gullies. Such badly eroded areas have reduced the amount of arable land, stimulating the growth of artisan industry. [F. Webster McBryde (*5*)]

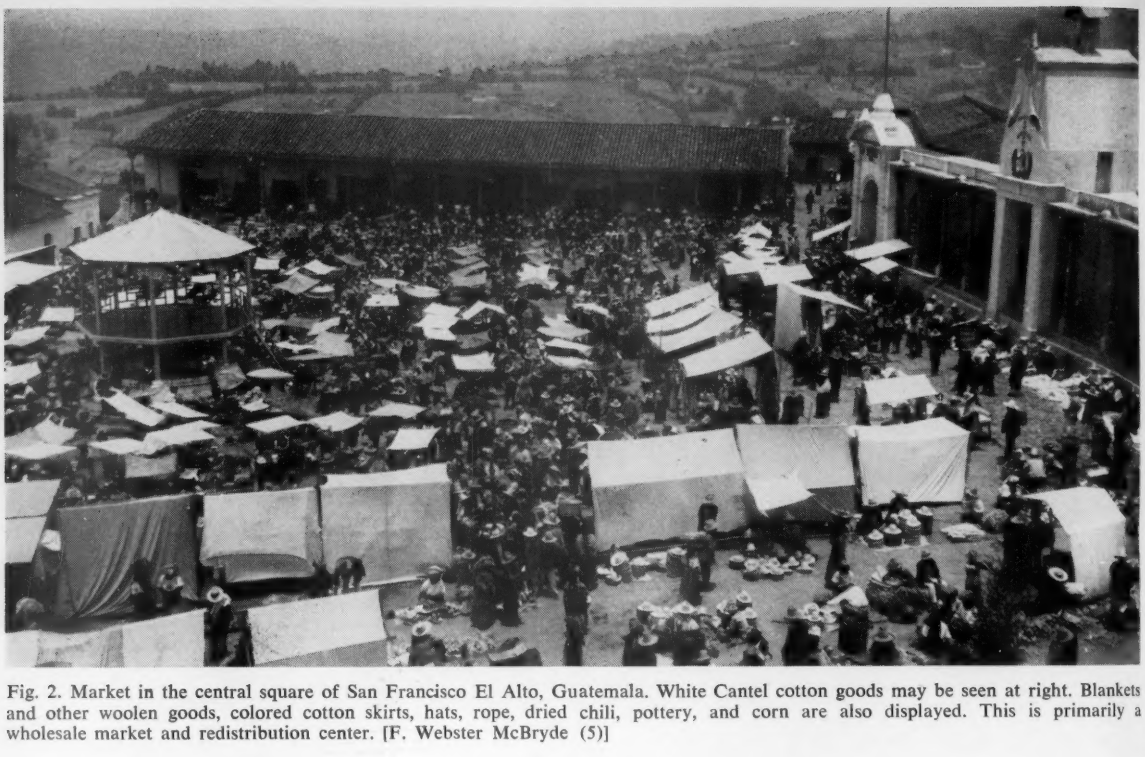


Fig. 2. Market in the central square of San Francisco El Alto, Guatemala. White Cantel cotton goods may be seen at right. Blankets and other woolen goods, colored cotton skirts, hats, rope, dried chili, pottery, and corn are also displayed. This is primarily a wholesale market and redistribution center. [F. Webster McBryde (5)]

are agricultural settlements, with house sites scattered among the cultivated fields.

The factory was set up in Pasac, one of the *cantones*, and a second compact settlement developed around it. The introduction of the factory generated some new social pressures. It caused modification of the settlement pattern, for factory workers require a compact residence area. It presented a new economic opportunity, involving new occupational roles and new behavior. Some of the Cantelenses employed by the factory had traditionally not been income earners, and thus, operation of the factory raised the net income of the *municipio*. It brought together workers under central direction in a production unit far greater in scale and in continuity of operation and far more complex in organization than anything Cantel had ever seen before.

For the individual, the radical changes introduced by the factory are more income, more contact with nonkinsmen in the work situation, and a work schedule geared to the factory instead of the farm. The factory worker has, very clearly, a wider range of alternatives than those who are engaged in traditional occupations. And the extent to which the factory workers reorganize their lives governs the degree of shift, modification, and innovation that occur in the society as a whole.

It was possible, in studying the effects of the factory on Cantel, to carry out two kinds of detailed comparisons: (i) a comparison of the social and cultural life of the factory worker with that of his agricultural counterpart; and (ii) a comparison of Cantel, viewed as a community, with surrounding communities which had no factory. The comparison between communities was made by comparing descriptions of neighboring communities with conditions in Cantel, and by visiting other Indian communities in the highlands. The internal comparison, between factory-employed persons and agriculturalists, was made on a "matched family" basis—by comparing families that were alike in age of members, number of children, and wealth, and dissimilar only in the occupation of the members.

The study of Cantel meets the methodological requirements of controlled comparison, for Cantel was similar to the surrounding Indian communities prior to the building of the factory. The factory was built in Cantel not because of special labor advantages or because the community was thought to be one in which innovation would be readily accepted, but rather because the river which flows through the *municipio* could provide the water power to run the turbines of the mill. This is the only instance of factory production in the region. Moreover, other agents of change are known and can be discounted. Altogether, this comes as close to being a "laboratory" situation as the social anthropologist is likely to find.

The study of Cantel sheds light on the way in which the process of smooth accommodation to industrial production was worked out and, at the same time, adds to our knowledge of the kinds of culture that are compatible with industrialization.

## The Small Differences

The Cantelenses who work in the factory still maintain the main features of their traditional way of life, but there are some small differences, and some larger differences too, between them and their farmer neighbors that are worth noting.

Factory workers' houses do not differ from other houses in Cantel in

any consistent way. The size of a house, its state of repair, and whether or not its adobe walls are covered with tinted whitewash depend in part on wealth. But the factory worker's income is not spent on decorating his home, any more than the agriculturalist's is. In his kitchen one finds the slapdash arrangement of utensils, the three-stone hearth, the windowless walls, the earth floor, and all the other features typical of a Cantel house. However, certain possessions characterize the domestic economy of factory workers and are largely restricted to them. Radios, wristwatches, bicycles, and canned goods are to be found primarily among factory personnel. The bicycle is useful only to factory workers, for with the same amount of money a farmer can buy a horse, much more useful to him. As for expenditures for food, the differences are differences of proportion. All of the items in the diets of factory workers are consumed at some time during the year by farmers, but factory families tend to consume the more expensive items more often and in greater quantity than do farm families.

On an ordinary working day it is difficult to distinguish the factory worker from the farm worker by his dress or costume. On fiesta days, however, the economic advantage of factory work is apparent, for at these times factory workers are uniformly better dressed than farmers and their families. Some factory men have adopted Ladino (non-Indian) dress. Factory women wear the same kind of clothing as nonfactory women, but they tend to buy finer skirts and blouses and to have a "wardrobe," rather than a single costume.

As for family life, there is virtual identity in the basic pattern of the factory worker's family and of the farmer's. The typical Cantel family is composed of a man, his wife, and their unmarried offspring, all living together in their own household. The family is the unit of consumption, production, worship and ritual, child rearing, and religious activity. It is the family which has a social status in the community, and it is the family, rather than individuals, which takes its turn in the discharge of civil and religious offices. The families of factory workers and farmers are similar in form and make-up but diverge in two respects. First, the greater economic resource of the factory family, in relation to the prevailing income in Cantel, promotes integration of the basic family by resolving some of the tensions that arise from having very limited means. Second, the factory worker takes on the support of his parents, should the need arise, at an early age and under conditions formerly not found in the community. These divergences have not so differentiated the factory family from the farm family that the potential friction-producing disparities in the social situation of the two groups are apparent.

As for their religious life and world view, the factory worker and the farmer of Cantel participate to the same extent in the activities of the Catholic Church and of related secular organizations, such as the "Christian mothers"

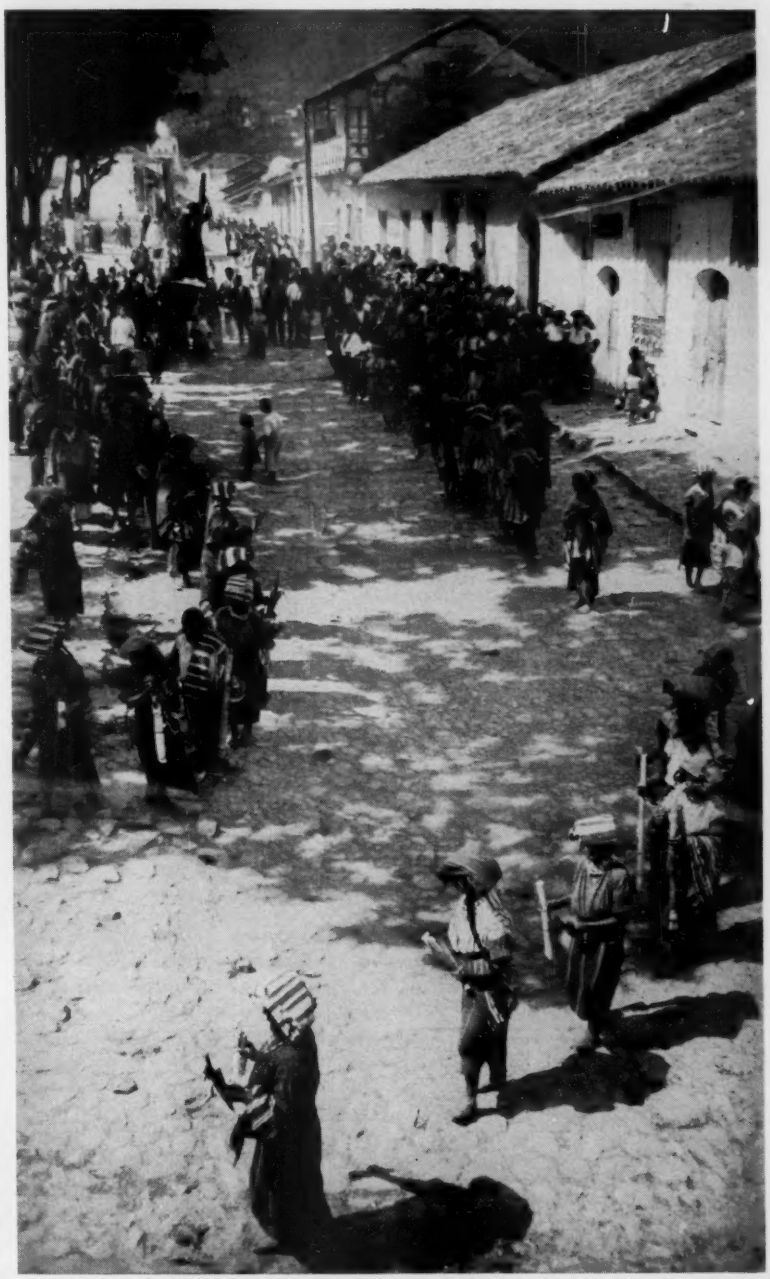


Fig. 3. An Easter procession in Sololá. Ladinos carry the richly clad image of Christ to the accompaniment of a dirge. In the foreground, Indian members of a *cofradia* or religious society carry lighted candles. The market is suspended for three days before Easter. [F. Webster McBryde (*5*)]

or the Catholic Action groups, and in the folk ceremonies of the corporate religious groups (*cofradias*), and they subscribe about equally to esoteric beliefs and practices. The corporate religious brotherhoods are groups of men who take care of the image of a given saint for a year. They light candles daily and observe the saint's day by celebrating mass and carrying the image in a procession through the streets of the town (Fig. 3). Every year the groups change, through a system of communal service and selection.

In addition to Cantel's nominal Catholics there is a small group of Protestants, numbering about 400. Factory workers have turned toward Protestantism with less frequency than have farmers or artisans. Protestantism, in a community like Cantel, is the religion of the marginal man. The embracing of Protestantism entails the reforming of personal habits. Cantelenses who feel a desire to reform are those who for some reason are not at ease in their social and cultural environment. The comparative rarity with which workers turn toward Protestantism is an indication that factory employment is not of itself a source of stress.

Unquestioning acceptance of folk ideas of reality is part of everyone's life, irrespective of his occupational role. In Cantel this includes acceptance of folk remedies, origin myths, modes of cure, and the belief that foods and persons are "hot" or "cold," that smoke from candles carries one's prayer to heaven, that the sacrifice of a sheep keeps death from a household, and that an eclipse is a battle between good and evil. What is apparent in this matter of world view is the extent to which spheres of rationality and irrationality coincide among factory and nonfactory workers. The factory has not changed traditional beliefs, nor have physical theories involved in the operation of the mill been extended to other areas of Cantel life. Factory workers understand, in empirical terms, how their machines work, and their approach to work is straightforward and technical, not mythopoetic or mystical. But they keep the mystical explanations for other aspects of their lives. It certainly poses no problem from the standpoint of analysis to note the coexistence of mythical and casual explanations in the same society, or in the same head, for that matter.

## The Larger Differences

One area of life where the differences between factory workers and farmers are greater is that of friendship and personal relationships. In traditional Cantel, friendship, in its Western sense, is virtually unknown. One interacts with relatives, not with neighbors or with friends. Before the factory was built there were no associations based on mutual liking or special interest. Fun and play were, and still are, for agri-

Fig. 4. Pottery in western Guatemala. (*a*) Common types of pottery for cooking and washing, made in San Cristobál Totonicapán and sold in the local market. (*b*) Ladino potter using a wheel. (*c*) Open-air firing of pottery with twigs and bunch grass. (*d*) Three Totonicapán merchants with pottery bought in the San Francisco El Alto market, heading for lowland Mazatenango. (*e*) Pottery in the San Juan Ostuncalco market. (*f*) Small ceramic ware from Totonicapán. (*g*) Pottery bought at San Francisco El Alto being sold by merchants in the Mazatenango market. [F. Webster McBryde (*5*)]

culturalists, part of the functional context of work and worship. The factory workers developed intimate personal bonds and friendships. Some of them had patterns of leisure much more like those of factory workers elsewhere than like those of Guatemalan Indian peasants. And because of the factory, a union was organized, as were a sports club, a bicycle club, and a basketball team. The union as a political structure was particularly important. Its full effect is seen not in the personal lives of the participants but in the shifting basis of social and political power which the union's entry into national and local politics initiated. The union formed a link between the community and the national government and tried to implement the national program of social change.

This union activity in a revolutionary decade in Guatemala, from 1944 to 1954, changed the political structure of the community and lessened the reliance on age and previous service to the community as criteria for leadership in local affairs. Since most factory workers were young, and since the leaders of the local union were therefore young, there was an increasing accent on youth in the competition for political and social power. This was an indirect result of factory production in this instance; the union came in the wake of the factory and the union came in a revolutionary decade. Factory production per se does not necessarily lead to a conflict between generations.

### Why Adjustment Worked Smoothly

The more general explanation of Cantel's smooth accommodation appears to be that *only* factory production was added to the community, unaccompanied by the simultaneous advent of new ideologies of political and social organization. The factory came into a community in which there had been ethnic continuity. People who were to work in the factory or join new political parties had already worked out a set of social understandings and personal relationships prior to the revolution.

A second factor was that the organization necessary for operation of the industrial firm was carried out beyond the bounds of the local society. The local society was not concerned with those special devices and social arrangements necessary to the operation of a firm in a situation where continued existence may depend upon fine calculation and maximization of production.

Third, there was no effective transfer of the means of social coercion to persons outside the local society. And no new social class arose in Cantel. Since outsiders did not possess the power necessary to make the Cantel factory worker an adjunct in the private search for profit or a statistical cog in some giant plan for rapid economic development, the old social system continued to be the chief means of achieving prestige and social control. No new social class arose, to try to make over Cantel in its own image, and outsiders could not treat the Cantelenses as so many units of manpower.

To judge from developments in Cantel, a people's ability to accommodate to new cultural forms is intimately related to the degree of control that they possess—or feel they possess—over their social circumstances. Their sense of control seems to stem from freedom to choose how they will combine the new elements, freedom to discard or accept innovations as their consequences become clear. The Cantelenses did not begin to accept the factory until threats of force had been withdrawn. When the factory stopped using national police to round up workers, and when the jailing of objectors had ceased, the people came to the factory, realizing that it afforded a means of implementing some of their goals.

Fourth, the new industry did not compete with established ways of making a living (Fig. 4). No significant part of the labor force was removed from farm work and artisan production. The economic depression due to decrease in native production, and the economic boom due to the introduction of new ways of production, that often follow industrialization of a native community, did not occur.

Fifth, the culture and social structure of Cantel contained many elements favorable to industrialization. The Cantelenses were used to handling money, used to appraising the economic advantages of various courses of action. The conditions of their work as farmers had disciplined them and accustomed them to continuous physical effort and regular work habits. The community as a whole valued industry, thrift, and work, and wealth was considered good. The culture was a receptive one, which for centuries had been selectively incorporating elements from national Guatemalan culture and world society.

Sixth, that the differences are not greater or that the occupational role is not more disruptive appears to stem from the evolution of restraining mechanisms within the family relative to the disposal of income. Younger sons and daughters turn over their income to their fathers, in either farm or factory families. Parents are able to insist on this because of shortage of houses—there is no place for a child to go unless he builds a house, and this requires parental aid. The tradition of duty to the parents and of the subordination of the child while he lives under his parents' roof, is strong.

### Conclusion

The story of Cantel does not mean that the lid is off and that any kind of productive system and any kind of institutional setting may coexist anywhere, nor does it mean that the introduction and operation of industrial technology can always be a relatively painless process in preindustrial societies. There were special circumstances in Cantel, as compared to those that existed during the industrialization of England or to those found in most contemporary situations where an effort is made to industrialize peasant and primitive societies.

Cantel is not the same society it was before the introduction of the factory. But it is still a going concern—a community with a distinctive way of life, rich in local meanings and in patterns of social relations very different from those of the societies which have invented and spread machine technology. Cantel's experience in adjusting to a new economic form means at least this: Factories may be introduced into peasant societies without the drastic chain of social, cultural, and psychological consequences implied in the concept of "revolution."

With Cantelenses working in the factory, the community's relation to surrounding communities has not been much altered. There has been no inrush of a foreign population, and there has been no great swell in traffic, in commerce, and in movement. The community still has its place in the regional marketing system, and it still exports wheat and corn (*1*).

Recent studies in Pakistan (*2*), in India (*3*), and in Japan (*4*) indicate that this is not an isolated, unique occurrence, but that industrialization of

peasants and primitives can be a creative social process. Cantel teaches the general lesson that the upheavals in people's lives that often go along with industrialization are not built into the process itself. They are probably the result of an image of man in social change which delineates him as the passive agent mechanically responding to immutable forces, or as the pawn in a political chess game, or as expendable material in an economic plan.


#### References and Notes

1. M. Nash, *Machine Age Maya* (Free Press, Glencoe, Ill., 1958) (contains a fuller description of Cantel); S. Tax, *Am. Anthropologist* **39**, 423 (1937) (describes the general pattern of the region); M. Nash, *Human Organization* **13**, 26 (1955).
2. A. F. A. Husain, *Human and Social Impact of Technological Change in Pakistan* (Oxford Univ. Press, Dacca, E. Pakistan, 1956).
3. M. Orans, "A tribal people in an industrial setting," *J. Am. Folklore* **71** (1958).
4. J. C. Abegglan, *The Japanese Factory* (Free Press, Glencoe, Ill., 1958).
5. The photographs are reproduced from F. W. McBryde, *Cultural and Historical Geography of Southwest Guatemala* (Smithsonian Institution, Institute of Social Anthropology Publ. No. 4, Washington, D.C., 1947), with permission.


# Science in the News

## American Group Studies Soviet Programs for Disseminating Scientific Information

During a recent trip to Moscow, a group of American information-processing specialists had an opportunity to learn about the Soviet Union's two principal programs for disseminating scientific and technical information, one conducted by the All-Union Institute of Scientific and Technical Information and the other, by a division of the State Scientific and Technical Committee. Five representatives of the National Federation of Science Abstracting and Indexing Services spent a week visiting the All-Union Institute, which is headed by I. A. Mikhailov. The institute's primary function is abstracting scientific and technical publications, both domestic and foreign. It operates under the U.S.S.R. Academy of Sciences; however, in some ways, not clearly defined, it is also related to the State Scientific and Technical Committee.

The American mission included Dale B. Baker, director of the Chemical Abstracts Service; G. Miles Conrad, director of Biological Abstracts; John C. Green, director of the Office of Technical Services, U.S. Department of Commerce; Mordecai Hoseh, Washington editor for the Chemical Abstracts Service; and Raymond A. Jensen, executive secretary of the federation.

The group started its study tour on 22 October with a general discussion session that was followed by a visit to the institute's systematization department, where about 15,000 periodicals are scanned for pertinent material and cataloged. Separate articles are distributed to the various editorial offices for more detailed examination. About 2500 to 3000 articles a day are received, in 65 languages, from 95 countries.

The group divided up in accordance with the special interests of its members to visit the different editorial offices, which assign papers to abstractors (usually professional scientists and engineers outside the organization), edit abstracts, compile indexes, and perform other routine editorial work. The institute has about 2000 employees and publishes some 14 abstracting journals.

### Machines and Express Service Explained

In a session presided over by S. M. Lisitchkin, first deputy director of the institute, the group met with machine searching and retrieval experts. Professor L. I. Gutenmakher and Dr. Sofer explained the construction and operation of an electronic logical machine that they are developing for use in retrieving chemical information. Later Mr. Rakov discussed and demonstrated the application of punched-card data-processing equipment to the institute's fiscal and statistical work.

The methods systems and machine research at the All-Union Institute are just getting organized. A. D. Cherny of the institute and the staff of Gutenmakher's laboratories, with the various editors cooperating, are in charge of this work. One of the visitors reports that an institute spokesman expressed the opinion that the claims made for electronic equipment have exceeded actual results.

In another session, led by Lisitchkin, the operation of the Express Information Services was explained. This activity is responsible for producing about 50 series of publications on various subjects of interest to workers in industry. So far the express service has functioned separately, but soon the work will be carried out by the staffs of the various abstracting journals. About 2100 foreign journals, mostly English-language publications, are selectively examined for articles to be summarized. The issues appear every 10 days.

Members of the group also met with Madame I. A. Lunacharskaya, head of the institute's acquisition and exchange department, to discuss mutual exchange problems and prospects for increasing the two-way flow of material.

### Cooperation Achieved

Throughout the visit, the U.S. group was especially impressed by the warm and friendly atmosphere in which the meetings were conducted. At the outset the visitors were invited to select whatever institute activities they most wanted to see. Questions were freely asked and freely answered, and detailed inspection of equipment and procedures was permitted. Team members believe that they are the first Americans to have been afforded such opportunities for examination of equipment and exchange of views.

Besides gaining insight into the operation of the institute and its component parts, the group reached an understanding on ways of obtaining closer cooperation in furthering the exchange of

technical and scientific literature, in compiling lists of periodicals, in procuring hard-to-obtain periodicals, and in exchanging information on documentation and machine methods of handling information. The group also achieved an understanding for closer cooperation between the institute and the federation, and groundwork was laid for future meetings between the two organizations.

### One of the Travelers Comments

An interview with Mordecai Hoseh, the only member of the group who could speak Russian, produced some interesting observations. Hoseh says that the Soviet position in information processing is in many ways similar to our own. As in the United States, workers in the field are not satisfied with present methods for handling the ever-growing volume of material and are constantly seeking new methods, although, contrary to the situation here, they are inclined to belittle the potential value of machines for this purpose.

Abstracting speed is about parallel with ours—in some fields fast and in others slow. In some cases abstracts of papers published in the United States appear in Soviet journals a year ahead of their appearance in this country, and vice versa. However, Soviet indexing is far behind ours, according to Hoseh, but he says that attention is being concentrated on this problem.

Hoseh emphasized one point. He feels strongly, and other members of the group concur, that information specialists and others visiting the U.S.S.R. must be careful to be objective in their observations. They must view facts. Hoseh commented that the Soviet government, like all governments, has interdepartmental rivalries, such as the one now raging between the U.S. Department of Agriculture and the Food and Drug Administration. He urged that visitors to the U.S.S.R. be careful to remain outside the inevitable internal conflicts or the whole purpose of a mission may be lost.

Hoseh also commented, as have so many others, that Soviet scientists and educators are held in very high esteem. However, he pointed out that this respect for the intellectual is by no means a purely Soviet characteristic, but rather a traditional European one.

### Industrial Information Agency

Although the U.S. group was formally visiting the All-Union Institute, John Green had a rewarding conference with Oleg A. Mikhailov, director of technical information for individual branches of industry for the State Scientific and Technical Committee. The committee, which is headed by Y. E. Maksarev, is under the Council of Ministers of the U.S.S.R. Mikhailov directs an organization that emphasizes service to industry and, in this objective, has a function similar to that of our own Office of Technical Services in the U.S. Department of Commerce, headed by Green. For some reason this industrial information agency has received scant attention in this country, although it is comparable to the All-Union Institute in importance.

A few weeks ago Burton W. Adkinson of the National Science Foundation attempted to remedy this when he returned from the International Federation of Documentation meeting in Warsaw. However, his remarks to the press were to some extent misinterpreted, and this led to reports that Mikhailov's agency was a secret one, newly discovered. Actually, it was described in the Soviet literature as early as 1957.

Adkinson, who heads the NSF Office of Scientific Information Services, says that it was his intention merely to call public attention to the fact that the U.S.S.R. has not one but two major information agencies, each quite different from the other. He points out that the highly centralized All-Union Institute has often been discussed, while Mikhailov's large, decentralized organization has hardly been mentioned.

### Operation Described

The details of the industrial unit's operation are not yet entirely clear to observers in this country. It is known that the agency selects, evaluates, and disseminates technical information, whether or not it has been previously published, through a network of industrial centers of various kinds. In the Soviet Union, each major industry has its own training and research institutes.

(Top) O. A. Mikhailov, director of technical information for individual branches of industry of the U.S.S.R.'s State Scientific and Technical Committee; John Green, director of the Office of Technical Services, U.S. Department of Commerce; M. Hoseh, Washington editor for the Chemical Abstracts Service; translator; V. V. Serpinsky, editor and chief of the *Referativnyi Zhurnal, Khimiya;* G. Miles Conrad, director of Biological Abstracts; A. I. Mikhailov, director of the All-Union Institute of Scientific and Technical Information. (Left) Dale B. Baker, director of the Chemical Abstracts Service; Raymond A. Jensen, executive secretary of the National Federation of Science Abstracting and Indexing Services; Intourist guide.

Mikhailov told Green that his main office had only about 60 employees, but that he had ten "Central Bureau Institutes" of information. Presumably these are bodies organized by industrial field, such as the Central Bureau of Scientific and Technical Information for Heavy Industry and the Bureau of Technical Information and Propaganda in the Meat Industry.

In each of these organizations 60 percent of the activity is devoted to processing information — acquisition, scanning, cataloging, abstracting, preparing, and so forth—and 40 percent to distribution. The central bureaus all publish journals, and each issue of these contains a prescribed number of suggestions to industry. Mikhailov also referred to 60 or 70 smaller regional units. In addition, he mentioned that his office maintains reporters at big plants.

Aside from the obvious organizational differences, the key difference between the All-Union Institute and the industrial information agency is that one provides broad scientific and technological information for which the user must ask, while the other feeds highly selected material to the predetermined user. Most observers agree that the two bodies complement each other.

The group from the National Federation of Science Abstracting and Indexing Services also visited centers in Poland, Holland, and Denmark. As a result of these travels, they concluded that there is no single national plan which merits adoption by all. Since alternate plans are feasible, any nation planning to make special efforts in this field should carefully inventory its existing methods of collecting information and its communication links. Thereafter a national plan should be devised which takes maximum advantage of these important resources and which responds to the country's special needs.

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## U.N. Assembly Asks All States To Halt Atom Tests

*Following are the texts of two resolutions adopted in New York on 21 November by the United Nations General Assembly which call for a halt in nuclear and thermoneuclear tests.*

The General Assembly, recalling its resolution 1252-B (XIII) of 4 November 1958.

Noting that the negotiations on the discontinuance of nuclear weapons tests and on the establishment of an appropriate international control system which began at Geneva on 31 October 1958 are still continuing,

1. Expresses its appreciation to the states concerned for their efforts to reach an agreement relating to the prohibition of nuclear weapons tests and including an appropriate international control system;

2. Expresses the hope that these states will intensify their efforts to reach an agreement at an early date;

3. Urges the states concerned in these negotiations to continue their present voluntary discontinuance of the testing of nuclear weapons;

4. Requests the states concerned to report to the General Assembly the results of their negotiations.

### Second Resolution

The General Assembly,

Desiring to safeguard mankind from the increasing hazards resulting from tests of nuclear and thermonuclear weapons,

Bearing in mind the profound concern evinced by the peoples of all countries regarding the testing of nuclear and thermonuclear weapons,

Welcoming endeavors at Geneva of the states concerned to reach an agreement on the discontinuance of these tests and the progress so far achieved,

Noting with appreciation that the states concerned have voluntarily suspended such tests, enabling progress in the discussions at Geneva,

Considering that an agreement on the cessation of nuclear and thermonuclear tests with effective international control is urgent,

1. Expresses its appreciation to the states concerned for their patient and sincere efforts to reach agreement on the discontinuance of nuclear and thermonuclear tests with effective international control and for the progress hitherto achieved;

2. Expresses further the hope that the states concerned will reach such agreement at an early date;

3. Appeals to the states concerned in the Geneva discussions to continue their present voluntary suspension of tests and to other states to desist from such tests;

4. Requests the states concerned to report to the Disarmament Commission and to the General Assembly the results of their negotiations.

## Scientists and Writers Discuss Public Misconceptions of the Nature of Basic Research

A close look at public attitudes towards science and scientists at the Thomas Alva Edison Foundation Conference on "The Mass Media and the Image of Science" on 6 November yielded some sharp opinions on the American citizenry's ability to absorb scientific information. Speakers at the Washington conference—attended by some 300 scientists, broadcasters, and journalists—deplored the public's narrow notions of what science is and what its real aims are.

Chief criticism came from National Science Foundation director Alan T. Waterman, who asked for change in the current image which identifies science "with technical industry and its product." Asserting that science has for too long been held "in the public view to be an entity unto itself, quite disassociated from other elements of our cultural heritage," Waterman urged directors of mass media to help build "a climate of excellence" in which science would be seen as an adventure of the mind and the spirit."

This view was seconded by John R. Platt, professor of physics at the University of Chicago, who said that the public is tired of facts—that "quiz-show facts" are not enough to yield a serviceable image of science. He asked science writers to take up the challenge of communicating what he called "the sweep and excitement" of basic science and the "intellectual thrills" it afforded.

A comparison of Russian and American attitudes showed the U.S. taking second place in this regard. Both Waterman and Princeton chemist John Turkevich, who recently visited the U.S.S.R., attributed a greater general appreciation of science to the Russians.

"Science controls the picture over there," Turkevich said. And he cited the close liaison between scientists and other creative people—artists, writers, and so on—in the U.S.S.R. as a major reason why Russians are generally better informed about scientific developments.

How much information is the American public absorbing? Depressingly little, was the report made by another participant at the Edison Foundation Conference. Earl Ubell, science editor for the New York *Herald Tribune*, reported on a recent survey undertaken

by the National Association of Science Writers and pointed out that though Americans apparently read news stories about science and medicine, they retain very little.

Ubell noted that the impact of "the massive distribution of information on the earth satellite . . . squirted [only] a trickle of data into the public's brain," and, he added, "the launching of the . . . satellites changed nothing of the public's attitudes towards science or towards scientists."

What to do to remedy the situation? Dael Wolfle, executive officer of the American Association for the Advancement of Science, doubted that a great deal could be done until the public itself had sufficient education in science. But he felt that "television has a superb opportunity" to contribute to that education. He asked for a "straight" — not sensationalist — treatment of science on TV and a presentation "not only of facts but also of the deeper understanding" necessary for an appreciation of news about science. Wolfle's challenge was immediately taken up by broadcasting executives participating in the conference. Edward Stanley, director of public affairs for NBC, and Irving Gitlin, a program executive for CBS News, cited a number of good science programs already being broadcast. But both Stanley and Gitlin noted the difficulties of producing shows that involve "abstract concepts." They agreed that the most successful shows are those which establish a "human relation"—that is, which have a direct emotional effect on the viewer or listener.

Science commentator Lister Sinclair of the Canadian Broadcasting Corporation also agreed that such impact was important in the broadcasting process. He held, further, that retention of facts was less important than an appreciation of "the scientific attitude," and he felt that broadcasting media could very effectively communicate that attitude.

As for the image of American science abroad, George V. Allen, director of the United States Information Agency, said: "Science information and U.S. scientific achievements form an increasingly larger proportion of the information made available through the USIA to project the image of the United States abroad. In fact, people overseas are more interested in American science and technology than in almost any other aspect of American life."

## College Testing Program Started

A new testing program for evaluating applicants for admission to college has been launched by the State University of Iowa. Known as the American College Testing Program, it began operation in November in 200 to 300 colleges and universities in 14 states in the Midwest, West, and South.

While similar in some respects to the present College Entrance Board tests, it is broader in scope. In addition to providing information for college admission, it will offer data useful for placement, scholarships, guidance, and counseling.

Whereas the College Entrance Board has 250 member institutions, the new program plans to serve the great mass of colleges that up to now have not subscribed to any testing service, according to E. F. Lindquist of Iowa State, director of research and development for the program.

The tests will evaluate intellectual capacities in English, mathematics, social studies, and the natural sciences. The scores will be available not only to the colleges but also to the student and his high school. In addition, the student's grades as a college freshman will be reported back to his high school to enable it to evaluate its curriculum.

The tests and administrative services will be provided by the Science Research Associates of Chicago, the Navy Reserve Officers Training Corps Program, and the National Science Foundation. Offices for program coordinators have been established in Alabama, Arkansas, Colorado, Idaho, Illinois, Iowa, Kansas, Kentucky, Minnesota, Missouri, Montana, Oklahoma, Tennessee, and Wisconsin. It is expected that California will start participating in 1960.

## Seaborg Wins Fermi Award

Glenn T. Seaborg, nuclear scientist and chancellor of the University of California, Berkeley, has been named to receive the Atomic Energy Commission's Enrico Fermi Award for 1959. He is being honored with the $50,000 prize for his outstanding work in the field of nuclear chemistry, including the discovery of plutonium and other transplutonium elements, and for his leadership in scientific and educational affairs. The award was recommended by the General Advisory Committee of the commission and was approved by President Eisenhower.

Glenn T. Seaborg, winner of the AEC's $50,000 Fermi Award.

A presentation ceremony will be held at AEC headquarters in Germantown, Md., at 12:30 P.M. on 2 December, the 17th anniversary of the day on which the late Enrico Fermi and his team of nuclear scientists proved that nuclear fission could be self-sustained and controlled when they operated the world's first reactor in a squash court under the stadium at Stagg Field at the University of Chicago.

## Cancer Research Leaders Form Organization

The directors of cancer research institutes in America have formed an organization, the Association of Cancer Institute Directors. The organizational meeting was held at Roswell Park Memorial Institute, Buffalo, N.Y. The new group is composed of the senior scientific executives of those institutions and autonomous divisions and departments whose principal activities are concerned with the study of malignant disease and the treatment of cancer patients.

The association has been established to support investigations of the causes, nature, treatment, and prevention of malignant diseases; to encourage the exchange of ideas, information, personnel, and special facilities between

groups with predominant interest in cancer; to foster educational opportunities in the biomedical sciences; to provide guidance to private and civil organizations concerning cancer research, education, and the care of cancer patients; and to expedite the dissemination of information by bringing together scientific executive officers of cancer institutes.

Officers elected at the first meeting are as follows: president, George Moore, director, Roswell Park Memorial Institute; vice president, Sidney Farber, director of research, Children's Cancer Research Foundation, Boston, Mass.; and secretary-treasurer, R. Lee Clark, Jr., director and surgeon-in-chief, University of Texas M. D. Anderson Hospital and Tumor Institute, Houston. Members of the association include representatives, also, of the National Cancer Institute, Bethesda; the Sloan-Kettering Institute for Cancer Research, New York; the Memorial Center for Cancer and Allied Diseases, New York; the Philadelphia Institute of Cancer Research; the Pondville Hospital, Boston; and the Detroit Institute of Cancer Research. The Association will, in the future, consider including members from among the scientific directors of cancer institutes of foreign countries.

## Scientists in the News

**Sir Julian Huxley**, British biologist, has received the $2500 Albert Lasker Award of the Planned Parenthood Federation of America for his "more than three decades of study and lucid interpretation of population phenomena." Huxley, who was formerly director general of the United Nations Educational, Scientific, and Cultural Organization, is now a visiting professor at the University of Chicago.

In England, **Sir Roger Makins**, at present Joint Permanent Secretary to the Treasury, has been named chairman of the Atomic Energy Authority, effective 1 January 1960. He succeeds **Lord Plowden**, who will become chairman of the British Aluminium Company.

**Clark P. Read** of Johns Hopkins University has received the American Society of Parasitologists' first Henry Baldwin Ward Medal for meritorious research in parasitology. The $1000 award, which will be conferred annually or less often at the discretion of the society, is sponsored by Parke, Davis and Company.

**Esther S. Anderson** has been elected national president of Sigma Delta Epsilon, honorary association of women scientists. Miss Anderson, formerly assistant professor of geography at the University of Nebraska, has recently been appointed geographer in the Areas and Statistical Branch of the Geography Division, United States Bureau of the Census, Washington, D.C.

**John R. Moore**, director of the Contract Division of the Atomic Energy Commission's Oak Ridge Operations Office, has been appointed director of the AEC's new Office of Contract Policy in Washington. The office will coordinate all policies, standards, and procedures pertaining to contracts awarded by the commission.

On 3 December the Metropolitan New York Chapter of the American Medical Writers Association will confer awards upon ten people for distinguished service in improving medical communication. The recipients will be **Walter C. Alvarez**, emeritus professor, Mayo Foundation; **Chauncey D. Leake**, professor of pharmacology, Ohio State University; **Eunice Miner**, executive director of the New York Academy of Sciences; **Robert D. Potter**, editor of *New York Medicine*; **J. E. Schmidt**, medical lexicographer; **William H. Stoner**, editor of *CA*, bulletin of the American Cancer Society; **Alvina R. Lewis**, executive editor of the *New York State Journal of Medicine*; **Alexander Gode**, chief of the Interlingua division of Science Service; **Martha E. Dana**, medical writer and editor; and **Edmund F. Lindner**, creative writer. The presentation ceremony will take place at the New York University School of Dentistry.

The Atomic Energy Commission has announced the appointment of **Myron B. Kratzer** as deputy director of the Division of International Affairs. He succeeds **Clark C. Vogel**, who resigned to take a position in industry. Kratzer has been assistant director for program development and liaison in the Division of International Affairs since November 1958.

**Karl E. Limper**, chairman of the department of geology at Miami University, has been named dean of the university's College of Arts and Science, effective 1 February. He succeeds **William E. Alderman**, who retired last summer after 25 years as dean.

**Bruno Zimm** of the General Electric Company Research Laboratory in Schenectady, N.Y., will be visiting professor of physical chemistry at Yale University for the spring term of the 1959–60 academic year.

**Saul Winstein**, of the University of California at Los Angeles, will be visiting professor of organic chemistry for the 1960–61 fall term.

**J. Allen Hynek** has been appointed chairman of the department of astronomy and director of Dearborn Observatory at Northwestern University, and **Karl G. Henize** has been appointed associate professor of astronomy. Both were formerly with the Smithsonian Astrophysical Observatory, Cambridge, Mass.

**Frederick W. O'Brien**, radiologist of Boston, Mass., has received the Gold Medal of the Radiological Society of North America.

The National Science Foundation has announced the appointment of **Richard H. Bolt** as associate director (research) and **Harry C. Kelly** as associate director (scientific education). Bolt will join the foundation on 1 January 1960. He will be on leave from the Massachusetts Institute of Technology, where he is director of the acoustics laboratory and professor of acoustics in the department of electrical engineering. At NSF he will be responsible for the foundation's activities in support of basic research in the sciences. He will succeed **Robert B. Brode**, who has returned to the University of California, Berkeley. The latter will continue his association with the foundation as special consultant to the director.

Kelly has been with the National Science Foundation since 1951 as assistant director for scientific personnel and education. In his new position, he will be concerned with over-all policy aspects of foundation support of scientific education and relationships with other agencies with responsibilities in this field.

# Book Reviews

**Ancient Population of Siberia and Its Cultures.** A. P. Okladnikov. Russian translation series of the Peabody Museum of Archaeology and Ethnology, Harvard University, vol. 1, No. 1. Peabody Museum, Cambridge, Mass., 1959. vii + 96 pp. Illus. $3.50.

The quantity and quality of Soviet scientific publication is by now too well known to require comment; nor is it necessary to belabor the point that a serious handicap is imposed on Western scholarship by unfamiliarity with this often inaccessible, unreadable corpus of data. The inauguration of a new Russian translation series is, therefore, a welcome event, especially in a still inadequately served field such as anthropology. It is true that we have had syntheses by Western scholars, occasional short translations in journals such as *American Antiquity*, and bibliographic and progress coverage by the COWA publications and by *Asian Perspectives*—all these being primarily archeological. But there was still need for complete, unabridged translations of larger works—translations which would convey the full flavor of the Russian original.

The present series is an important step in this direction, so far as physical anthropology and archeology are concerned. Conceived and edited by Henry Field, the series is, in effect, a continuation of his earlier (1935–46) program of brief reports on Soviet anthropological work. Both editor and publisher are to be congratulated for offering this service to the Western scientific world. I might add that the format chosen is satisfactory as well as practical; that the illustrations are well reproduced; and that the maps have been redrawn for the English reader.

The choice of a synthesis of Siberian prehistory for the initial number was logical and commendable, for this topic is perhaps the one of widest interest to the American scientific audience. The work chosen for translation was probably the best selection currently available, since it presents, in 65 pages, an over-all survey of the major prehistoric cultures of Siberia, from the earliest traces of man to approximately A.D. 1000. Despite the title, the treatment of ancient populations is only incidental. The author, a distinguished Soviet archeologist and scholar, is the leading authority on the prehistory of eastern Siberia; in fact, we owe the greater part of our knowledge of this vast and difficult region to his pioneer field work of the last 30 years. Naturally, his own views and interpretations are reflected in this part of the coverage, and informed readers may find themselves in disagreement on certain points. For the rest of Siberia, the author follows the most authoritative opinion of the moment among Soviet archeological workers.

Quite understandably, the treatment of so broad and complex a subject can only be superficial in the present instance, but this superficiality is aggravated by the popular style of the presentation. Still, the book will provide a useful background for the beginner and convey to the uninitiated scholar some idea of how much is now known about this supposedly blank spot on the map of human history. However, the complete lack of documentation—except for a brief list of suggested readings—severely limits the value of this work for the serious student, who would like, above all, a guide to the literature for further research. In this and other respects it is, therefore, no substitute for critical analyses of the subject by Western scholars, such as are regularly chronicled in the *COWA Bibliography* for Northern Asia (Council for Old World Archaeology, 11 Divinity Avenue, Cambridge, Mass.) or presented in more detail in *Asian Perspectives*, the bulletin of the Far Eastern Prehistory Association (Department of Anthropology, University of Arizona, Tucson).

These drawbacks are in no way a reflection on the author. The work was designed as a chapter in a popular handbook written for a general audience, and it admirably fulfilled that purpose. The editors have done Okladnikov a disservice in not making this clear, and in offering this volume to their readers, in effect, as an example of the author's scientific writings or of Soviet archeological scholarship in general—which it is not. Moreover, appropriate editorial annotation would have materially enhanced the value of the translation. The Western reader who is unfamiliar with the subject deserves this amount of guidance to avoid misconceptions; the scholar, capable of reading the book critically, would have no occasion to utilize an elementary work of this nature. For instance, the equation in the text of the Mousterian stage with the Riss glaciation will puzzle most readers or lead them to question the reliability of Soviet writings. A footnote by the editor could easily have cleared up this point. As it is, the only two editorial notes in the entire translation (contributed, we should note, by an outsider) relate to trivial points of Sinological scholarship. Such minute accuracy in these two cases leads the unsuspecting reader to assume that the remainder of the text has been subjected to equally careful screening—and it palpably has not. All in all, it is not too clear just what audience will be served by such a series in its present unannotated form.

It is also deplorable that without explanation, certain Russian terms are left untranslated (for example, *Chukot, chum, pisanitsa*), for they will be meaningless to anyone likely to read this publication. In the text the native names of Siberian tribes should have been accompanied by the equivalents familiar to Western students. The translation itself is not invariably above criticism: the meaning of certain passages is not clear unless one has recourse to the Russian original, and there are examples of poor choice of words (*pamiatnik* should not be rigidly rendered as "monument" in contexts where this is ridiculous, and to consistently refer to a blade as a "plate" destroys the meaning completely). The statement at the head of the bibliography makes no sense whatsoever and is evidently the result of

jumbling the translator's manuscript. There are careless errors in the rendition of proper names—for example, the famous site at Uolba Lake is variously rendered as Wolba and Yolba. And, lastly, there are an unnecessary number of typographical errors, despite the fact that, as the introduction takes pains to assure us, the typist is a Harvard graduate. I was disappointed to find on the first three pages of the text seven typographical errors, three errors of transcription, three instances of poor or unintelligible translation, and one obvious error in the Russian original faithfully reproduced (the Irtysh River is not by any stretch of the imagination in north*western* Kazakhstan).

All these shortcomings can surely be attributed to overhasty editing of the translation. May we therefore plead for just a little more care and effort in preparing the forthcoming publications on the Caucasus and Central Asia; such care and effort would immeasurably increase the value of this decidedly worth-while project.

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**The Social History of Lighting.** William T. O'Dea. Macmillan, New York, 1958. xiii + 254 pp. Illus. $8.50.

Not since Henri d'Allemagne wrote *Histoire du Luminaire* in 1891 has the subject of artificial lighting been treated historically with so much care and authority as William O'Dea treats it here. Written with style and wit, having an almost anthropological perspective, and packed with well-documented information, this book will serve equally the historian of science and culture, the antiquarian, or the mere browser who enjoys pleasant reading in unusual byways.

O'Dea avoids the developmental or evolutionary approach to the history of lighting and also steers clear of the purely chronological approach. Instead, he divides his chapters under functional heading, according to the principal ways in which light has played a part in social history: "Light for the home," "Light for travel," "Light for work," "Light in worship and superstition," for example. The last two chapters deal with "The materials of light" and "Getting a light."

In the beginning chapter, entitled "Bad light," we learn of the nocturnal difficulties that were endured by every one before 1800. When Boswell inadvertently snuffed out his candle while writing late at night, he had to wait for the night watchman and then call out the window for a light, lest in groping about for a tinder box he should disturb his landlord and be shot as a burglar. When tallow candles were the only means of stage lighting, "it was nothing for a snuff boy to come before the audience in the middle of the most emotional scene in order to tend a smoking candle."

The text is enlivened and documented not only by bright literary allusions but also by a splendidly chosen series of plates reproducing paintings, prints, and drawings that depict lighting devices in use. There are also many line drawings interspersed through the text.

One is constantly surprised by the encyclopedic coverage of the subject matter and by the broad frame of reference which surrounds it. The revolutionary importance of Ami Argand's combined invention of the tubular air-draft burner and the glass chimney in 1783 is reiterated here. But for the first time in a general history of lighting, it is shown how the balloon ascension of Argand's friends, the Montgolfier brothers, so completely overshadowed the new lamp that Argand was unable to attract enough attention to the lamp to cause its development. Only the unscrupulous Quinquet seems to have been aware of its significance and to have used the knowledge for his own ends. The point is gracefully stressed by quoting Dr. Johnson's remark to Mrs. Thrale: "You will observe, Madam, that the balloon engages all mankind."

We learn that Menier, the French chocolate manufacturer, lit his factories with arc lights in 1875, that Pullman cars were first lighted by kerosene lamps in 1874, and that the Duke of Brunswick illuminated a garden fete in 1741 with 5000, or more, float-wick oil lamps. We are told that Hooke in the 17th century used a spherical water condenser with sunshine as the source of light for his microscope, and that a scheme to illuminate the roof of the Capital in Washington, D. C., with arc lights in 1884 was vetoed after a trial period. An entire chapter is devoted to the history of lighthouses; this chapter begins with the Pharos of Alexandria, touches on the coal-burning beacons of 17th- and 18th-century England, and ends with the electrification of these houses, which was started as early as 1858.

It is, perhaps, a commentary on the inadequacy of published studies on American lighting that O'Dea devotes little space to it. Little is said of the important role that whale oil played in early 19th-century lighting in America, and one wishes that the oft-repeated story which attributes to Franklin the invention of the two-tube whale-oil burner had been either avoided or substantiated.

The single, mechanical improvement in the organization of the book that I can suggest is to include plate numbers on the plates, since they are referred to by number in the text. For a work so thorough and so well-documented, however, these are merely quibbles. It is an excellent book, much the best that has yet been done on this subject.

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**Advances in Chemical Physics.** vol. 2. I. Prigogine, Ed. Interscience, New York, 1959. ix + 412 pp. Illus. $11.50.

This second volume of the series maintains the high standards established by volume 1 [*Science* **129**, 833 (1959)]. Although many topics are treated, emphasis is placed on new developments in the theoretical evaluation of molecular electronic energies and on properties determined by electron dynamics. The extensive review of the many-electron problem in quantum mechanics is not only useful but also timely, in view of the great effort currently being applied to this problem.

The articles are rather uniformly of a review character, with some mention of important unsolved problems and some speculation on the nature of possible future developments.

The contents convey a reasonably accurate impression of what this volume has to offer. "Clathrate solutions" (57 pages), J. H. van der Waals and J. C. Platteeuw; "Inter- and intramolecular forces and molecular polarizability" (25 pages), Kenneth S. Pitzer; "The solubility of solids in compressed gases" (34 pages), J. S. Rowlinson and M. J. Richardson; "Thermodynamics of metallic solutions" (28 pages), R. A. Oriani; "Recent advances in polymer

chemistry" (40 pages), M. Szwarc; "Nuclear quadrupole resonance in irradiated crystals" (20 pages), Jules Duchesne; "Correlation problem in many-electron quantum mechanics. I. Review of different approaches and discussion of some current ideas" (116 pages), Per-Olov Löwdin; "Correlation problem in many-electron quantum mechanics. II. Bibliographical survey of the historical developments with comments" (43 pages), Hiroyuku Yoshizumi; "The problem of barriers to internal rotation in molecules" (27 pages), E. Bright Wilson, Jr.

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**Exotic Zoology.** Willy Ley. Viking, New York, 1959. xii + 468 pp. Illus. $4.95.

The art of writing a book with two primary objectives in mind has been attained by Willy Ley in his new book on natural history. Instead of making new editions of *The Lungfish, the Dodo, and the Unicorn* (1941, revised 1948), *Dragons in Amber* (1951), and *Salamanders and Other Wonders* (1955), Ley has selected the most pertinent and interesting portions of each of these books, rewritten some of the sections, and brought them all up-to-date. This material makes up about one-half of the new book, *Exotic Zoology;* the remainder consists of new material not previously published in book form. Thus, a blending of the old and the new has produced one of the most enchanting books on natural history to appear in recent years.

This is the age of the specialist, and such a person should be able to take any chapter of *Exotic Zoology* and write it to death. Instead of this, Ley investigates a number of subjects from two points of view—their historical development in the knowledge of man, and their place, if any, in the evolutionary pattern of life as a whole. This use of both historical and zoological data gives the reader the impression that this is a well-rounded and authoritative book without giving him the feeling that he is reading a textbook. However, no textbook that I have read has the range of factual material that this book has.

*Exotic Zoology* is divided into five parts. The first part is appropriately titled "Myth?" It discusses the unicorn in legend and fact, the legends of the survival of large reptiles (dinosaurs?), the Abominable Snowman, and the various legends of the little people—not fairies, but real little people. Pygmies exist, true, but do the descendants of the australopithecines still live in the deep forests of Africa?

The second part, "Records in stone," develops the dragon myths in fact and fiction and includes a very good discussion of the woolly mammoth. A side diversion on the flying dragons—the early bird-reptiles (or is it reptile-birds) —completes this section.

In part three, "Oceanic mysteries," we rove among the strange stories of the Kraken and the scientific basis for belief in huge cuttlefish types in the sea. The sea serpent is treated in a manner that is sympathetic, scholarly, and scientific. The almost unbelievable, large coco-de-mer nut and its strange struggle for existence is one of the botanical puzzles of the world, and it is told here. The spawning habits of the eel complete this section on natural history puzzles.

We find in part four, "Some fabulous islands," the stirring accounts of the extinct moas, and to me, the always intriguing stories (both factual and legendary) of the poison Upas tree. However, the man-eating tree is traced back to a well spun yarn. On the other hand, the Dodo did exist. It played a part in the history of exploration, similar to the role played by the large number of huge tortoises on the islands off the coast of South America.

To conclude this fascinating book, the author (in part five), delves into "Witnesses of the past." Such a hidden treasure house is Australia and its various fauna. Even today, mysteries unfold —such as the discovery of the 200-million-year-old coelacanth—and assure us that adventure is not dead.

To end this journey through space and time, Willy Ley takes us to the continent of mystery, Africa, and the strange and unsuspected animals that turn up there. Such a large animal as the okapi was unknown before 1900. Other primitive types have been found, and the concluding sentence, "And the Congo peacock raised again the old but still open question: what else may be hiding in the Rainy Forest . . . ?" expresses my sentiments completely.

The personal anecdotes, the almost homey treatment, and above all, the careful erudition of Willy Ley will attract the natural and the physical scientist, as well as the layman.

The appendixes contain tables that aid in reading the book, namely, "Sequence and duration of geological periods," and "Animals and climate in northern Europe during the Pleistocene period." Olga Ley's well-done and wisely chosen illustrations add a great deal to the pleasure of reading this book. If you are interested in the world about you, you will like Willy Ley's *Exotic Zoology*.

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**Navaho Art and Culture.** George Mills. Taylor Museum, Colorado Springs Fine Arts Center, Colorado Springs, Colo., 1959. 221 pp. Illus. + plates.

To what extent does the art of a people reflect the values and the character of the society that produces it? George Mills, dissatisfied with the intuitive nature of previous studies of this problem, has sought a more objective method of attacking it. Choosing as his people for study the Navaho Indians of the American Southwest, he first seeks to analyze each of four of their artistic media—the traditional arts of weaving, silverwork, ceremonial drypainting (commonly referred to as sandpainting), and a series of freehand, crayon drawings made for him in 1951–52 under conditions he imposed. He finds some 20 artistic traits which are common to all four media and designates them significant from the viewpoint of cultural values.

Mills then summarizes the major premises of the Navaho way of life as he has determined them from analysis of the literature on the tribe, written by cultural anthropologists. He then seeks to find psychological interpretations for the 20 Navaho artistic traits in the literature on the psychology of art in which the meanings of similar traits in the art of non-Navaho peoples are considered. And finally, he compares these interpretations with the major premises of Navaho life as revealed in the writings of students of the whole culture.

These correlations, for the most part, are very striking. They suggest that Navaho art is, indeed, an integral part of Navaho culture, which reflects the psychological characteristics and cultural values of these people. Furthermore, Mills finds that interpretations

of their art indicate that the Navahos are both more emotional and more inclined to look upon aliens as sources of good, as well as evil, then students of their culture had recognized.

To most readers this book will be of greatest interest as a pioneer effort to introduce rigorous method and objectivity into the study of the relationship between art and total culture. In his concluding chapter Mills shows his awareness of two weaknesses in his methodology. His knowledge of Navaho culture inevitably influenced his selection and definition of typical traits in Navaho art. Faced with conflicting interpretations of artistic traits by different psychologists, he chose the ones which seemed to fit the Navaho cultural situation best. One must admire him for the ingenuity and earnestness of his efforts and for his frank recognition of their shortcomings.

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**Comparative Endocrinology.** Proceedings of a symposium. Aubrey Grobman, Ed. Wiley, New York; Chapman and Hall, London, 1959. xx + 746 pp. Illus. $15.

This volume is a collection of 43 papers presented at the Columbia University symposium on comparative endocrinology which was held 25–29 May 1958. The volume also includes brief reports of the discussion that followed many of the papers (in most cases the discussion is of modest interest), an index of animal names, and a subject index. The editorial work is excellent. The appearance of these papers within a year of the symposium represents an achievement for which both the editorial staff and the contributors should be congratulated.

The papers range from rather broad reviews to quite precise presentations of research. Almost without exception, they are well-written and informative. The general areas covered in these contributions are: (i) endocrine factors in behavior and ecological adaptation, (ii) neurosecretory systems, (iii) comparative morphology and physiology of the thyroid, hypophysis, adrenal, and pancreas, (iv) and comparative endocrinology of reproduction.

None of the papers are clinical in orientation, and many are comparative in the strict sense of the word, for they make significant use of species as an experimental variable. However, very little attention is devoted to invertebrate endocrine systems, and those contributions which present recent information in this area are addressed to general physiological aspects of endocrinology rather than to the comparative aspects. Exceptions to this are the brief reviews by Berta Scharrer and Ernst Scharrer of neurosecretory systems, and a paper by E. J. W. Barrington on the endocrinology of the protochordates. Hence, "Comparative Vertebrate Endocrinology" would be a more appropriate title for the book.

This volume clearly deserves a place on the bookshelves of workers concerned with comparative endocrinology. It also deserves a broad distribution on the shelves of biologists not directly concerned with this area, but it is, unfortunately, not likely to achieve this broader distribution. This is due partly to the necessarily ephemeral interest of summaries in such a rapidly developing field, but primarily to the high price necessary to defray publication costs of the volume. The paper and binding are good, and the illustrations are numerous and well reproduced. Thus, there is no doubt of value received, but the cost of $15 will discourage casual interest. This is a pity.

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## New Books

*Adolescent Aggression.* A study of the influence of child-training practices and family interrelationships. Albert Bandura and Richard H. Walters. Ronald, New York, 1959. 487 pp. $7.50.

*Advances in Catalysis and Related Subjects* vol. 11. D. D. Eley, P. W. Selwood, Paul B. Weisz. Academic Press, New York, 1959. 394 pp. $12.50. Contents: "The kinetics of the stereospecific polymerization of α-olefins," G. Natta and I. Pasquon; "'Surface potentials and adsorption process on metals," R. V. Culver and F. C. Tompkins; "Gas reactions of carbon," P. L. Walker, Jr., F. Rusinko, Jr., L. G. Austin; "The catalytic exchange of hydrocarbons with deuterium," C. Kemball; "Immersional heats and the nature of solid surfaces," J. J. Chessick and A. C. Zettlemoyer; "The catalytic activation of hydrogen in homogeneous, heterogeneous, and biological systems," J. Halpern.

*Africa.* Its peoples and their culture history. George Peter Murdock. McGraw-Hill, New York, 1959. 469 pp. $11.75.

*America in the Antarctic to 1840.* Philip I. Mitterling. Univ. of Illinois Press, Urbana, 1959. 211 pp. $5.

*Analytical Chemistry of Titanium Metals and Compounds.* Maurice Codell. Interscience, New York, 1959. 391 pp. $12.

*Analytical Cytology.* Methods for studying cellular form and function. Robert C. Mellors, Ed. McGraw-Hill, New York, ed. 2, 1959. 544 pp. $17.50.

*Applied Solar Energy Research.* A directory of world activities and bibilography of significant literature. Jean Smith Jensen, Ed. Assoc. for Applied Solar Energy, Phoenix, Arizona, 1959. 296 pp.

*Biophysical Science—A Study Program.* J. L. Oncley, Ed. Wiley, New York, 1959. 648 pp. $6.50.

*The Conceptual Foundations of the Statistical Approach in Mechanics.* Paul and Tatiana Ehrenfest. Translated by Michael J. Moravcsik. Cornell Univ. Press, Ithaca, N.Y., 1959. 130 pp. $3.

*The Death of Adam.* Evolution and its impact on Western thought. John C. Greene. Iowa State Univ. Press, Ames, 1959. 400 pp. $4.95. This book was the winner of the 1959 Iowa State Centennial award for "the most outstanding manuscript written by an Iowa State faculty member."

*Engineering Thermodynamics.* An introductory text. D. B. Spalding and E. H. Cole. Arnold, London; McGraw-Hill, New York, 1959. 383 pp. $8.50.

*Exploding Wires.* Based on conference on exploding wire phenomenon, April 1959. William G. Chace and Howard K. Moore, Eds. Plenum Press, New York; Chapman and Hall, London, 1959. 373 pp. $9.50.

*Explorations—East of the High Andes* (from Patagonia to the Amazon). Victor Oppenheim. Pagent Press, New York, 1958. 267 pp. $5.

*Ferrites.* Physical properties of ferrimagnetic oxides in relation to their technical applications. J. Smit and H. P. J. Wijn. Wiley, New York; Philips' Technical Library, Eindhoven, Netherlands, 1959. 383 pp. $10.

*General Biology.* William C. Beaver. Mosby, St. Louis, Mo., ed. 5, 1959. 775 pp. $6.75.

*A Guide-Book to Biochemistry.* Kenneth Harrison. Cambridge Univ. Press, New York, 1959. 158 pp. $3.50.

*Human Heredity.* Ashley Montagu. World Publishing, Cleveland, Ohio, 1959. 397 pp. $5.

*Introduction to Theoretical Meteorology.* Seymour L. Hess. Holt, New York, 1959. 376 pp.

*John Dewey: Dictionary of Education.* Ralph B. Winn, Ed. Philosophical Library, New York, 1959. 160 pp. $3.75. A compilation of Dewey's theories and statements.

*Lehrbuch der Theoretischen Physik.* Georg Joos. Akademische Verlagsgesellschaft, Frankfurt am Main, Germany, 1959. 835 pp.

*Medizinische Grundlagenforschung.* vol. 2. K. Fr. Bauer, Ed. Thieme, Stuttgart, Germany, 1959. 835 pp. DM. 168.

*Modern Electronic Components.* G. W. A. Dummer. Philosophical Library, New York, 1959. 480 pp. $15.

# Reports

## Eastern Equine Encephalitis Virus Isolated from Culex nigripalpus in Trinidad

*Abstract*. The isolation of the first strain of eastern equine encephalitis virus in Trinidad, West Indies, is described. The virus came from a pool of *Culex nigripalpus* mosquitoes collected from chicken-baited traps in May 1959.

Previous evidence for the presence of eastern equine encephalitis virus in Trinidad was based on the finding of neutralizing antibody to this virus in two separate serum specimens collected in 1954 from the same native donkey (*1*).

In May 1959, a pool of 512 *Culex nigripalpus* yielded eastern equine encephalitis virus. The mosquitoes, of which 498 were gravid and many were engorged, were collected between 2 and 9 May from two chicken-baited traps located on La Fortune and Esperanza cocoa estates, Vega de Oropouche, about 4 miles northeast of Sangre Grande.

The mosquitoes were ground in 3 ml of bovalbumin diluent, subsequently diluted 1:3 after centrifugation, and inoculated intracerebrally into a group of seven 2-day-old white mice. On the 5th postinoculation day one mouse died and the brain of a second moribund mouse was passaged intracerebrally and intraperitoneally to two further groups of suckling mice and intracerebrally to a group of adult mice. The former all sickened or died by the 2nd day, but some of the adult deaths did not occur until the 3rd day. The agent responsible for these deaths passed readily through a bacteria-tight Seitz-EK pad. On further passage the virus killed suckling and adult mice regularly within 2 days of inoculation.

The virus was reisolated from the original mosquito suspension, which was inoculated undiluted into suckling mice by the intraperitoneal route. An attempt to reisolate the virus in chick embryo tissue cultures was unsuccessful.

An acetone-ether-extracted hemagglutinin was prepared from the brains of infected suckling mice. The virus was shown by hemagglutination-inhibition tests to be a member of group A (*2*). Complement-fixation tests were performed with crude saline and acetone-ether-extracted antigens prepared from the brains of infected suckling mice. Various group A antisera were used in these tests, including eastern equine encephalitis and western equine encephalitis hyperimmune mouse sera prepared in the New York laboratories of the Rockefeller Foundation from North American strains of these viruses. With the crude saline antigen, positive reactions were obtained with eastern and western equine encephalitis antisera, and negative reactions with Semliki Forest, Sindbis, Mayaro, and Venezuelan equine encephalitis antisera. The acetone-ether-extracted antigen gave a positive reaction with the eastern equine encephalitis antiserum and a negative reaction with the western equine encephalitis antiserum.

In neutralization tests in mice the virus was neutralized by immune and hyperimmune mouse sera prepared from a North American strain of eastern equine encephalitis virus but not by immune mouse serum prepared from western equine encephalitis virus. It was also neutralized by serum obtained from the native donkey referred to above. No strains of eastern equine encephalitis virus were kept at this laboratory prior to this isolation.

One of the five chickens used as bait in the mosquito traps developed neutralizing and hemagglutination-inhibiting antibodies to the virus between 2 and 16 May (*3*).

*Addendum*. Since submitting this paper for publication, we have made two more isolations of eastern equine encephalitis virus, both from pools of *Culex (Melanoconion) taeniopus* collected in the traps mentioned above. Strain 1 (TRVL 25780) came from a pool of 249 mosquitoes collected between 5 and 22 Aug. 1959 and suspended in 2 ml of diluent. Strain 2 (TRVL 26263) came from a pool of 142 mosquitoes collected between 1 and 11 Sept. 1959 and suspended in 3 ml of diluent. Both strains were successfully reisolated from the original suspensions. It is noteworthy that the original *nigripalpus* strain was isolated in May, when bird migration was northward. The two *taeniopus* isolations occurred at a time when bird migrations had reversed and were headed southward. Mosquito collections from the same two traps have been made continuously since September 1958. We have no evidence of eastern equine encephalitis activity in Trinidad other than the information provided above.

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### References and Notes

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2. J. Casals and L. V. Brown, *J. Exptl. Med.* **99**, 429 (1954).
3. The studies and observations on which this report is based were conducted with the support and under the auspices of the Government of Trinidad and Tobago, the Colonial Development and Welfare Scheme, and the Rockefeller Foundation.

22 July 1959

*Instructions for preparing reports.* Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper.

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* **125**, 16 (1957)].

## The Clock Paradox

*Abstract*. In Minkowski space, a coordinate system can always be chosen so that the straight line (geodesic) joining two events (not on a null line) is either parallel to the time axis or parallel to the space axis. In either case the geodesic has maximum length (time dilatation and Lorentz contraction).

In a recent report [*Science* **129**, 1359 (1959)] C. C. MacDuffee shows that, in special relativity, the equation of motion of a one-dimensional unaccelerated particle (that is, the equation of a geodesic in Minkowski space) is a straight line $x = at + b$ (where $|a| < 1$ in units such that the velocity of light is 1). He then proves that a geodesic joining two points $P_1$ and $P_2$ has maximum length (time dilatation or clock paradox).

The latter proof is considerably simplified by noting that there is no loss of generality in choosing $a = 0$. Physically this amounts to choosing an inertial system whose $t$-axis is parallel to the $P_1P_2$ geodesic; this is always possible if, as assumed, $|a| < 1$. Mathematically,

it amounts to observing that $x = at + b$ can always be reduced to $x =$ constant by a linear transformation for which $dt^2 - dx^2$ is invariant.

Then in the coordinate system for which the geodesic $P_1P_2$ is $x =$ constant, the space-time interval $ds$ is a pure time interval $dt$ (since $dx = 0$). The elapsed proper time is

$$\int_{t_1}^{t_2} dt = t_2 - t_1$$

The concept of the same place at two different times *is* meaningful in this reference frame; $P_1$ and $P_2$ are the same place at two different times. Now for any other arc joining $P_1$ and $P_2$, say $x = x(t)$, with

$$\left|\frac{dx}{dt}\right| < 1$$

(the latter condition makes the arc a possible path of a particle), the proper time is given by

$$ds = \sqrt{dt^2 - dx^2} = \sqrt{1 - (dx/dt)^2}\, dt < dt$$

$$s_2 - s_1 = \int_{P_1}^{P_2} ds < \int_{t_1}^{t_2} dt$$

—that is, the proper time is largest for a geodesic.

Exactly the same proof, for the case slope of $P_1P_2 < 1$, gives $t = ax + b$, $|a| < 1$ (or $t =$ constant in an inertial system whose $x$-axis is parallel to $P_1P_2$), and shows that the distance between two points is longest along a geodesic. This is the Lorentz contraction: an object measures longest in its rest system.

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29 June 1959

## Serological Procedure for the Detection of Antibodies to Penicillin

*Abstract.* A hemagglutination technique for demonstrating antibodies to penicillin in sera from penicillin-allergic subjects is described. Erythrocytes coupled to penicillin T by means of bis-diazotized-benzidine constitute the "antigen" used to measure the antipenicillin antibody. The hemagglutination reaction is highly specific, as indicated by hemagglutination-inhibition studies. The clinical significance of these antibodies remains to be elucidated.

The antigenic property of penicillin is recognized by such in vivo methods as the skin scratch and intradermal tests and the conjunctival test. However, little is known of the nature of the antibody to penicillin. It has been demonstrated by passive transfer techniques (*1*), and recently an in vitro demonstration of circulating antibody has been reported by Ley *et al.* (*2*). Watson and his colleagues (*3*) describe an attempt to characterize the penicillin antibody by electrophoretic studies in starch gels.

This paper reports a new serological technique for detecting antibodies to penicillin. The principle of coupling the antibiotic to the erythrocyte by means of bis-diazotized-benzidine (BDB) is used to prepare the "antigen" (*4*). The bis-diazotized-benzidine provides a stable bond between the penicillin and the red cell. Hemagglutination occurs when cells sensitized in this fashion are mixed with the serum from certain individuals who are hypersensitive to the drug. The pattern of agglutination obtained resembles that seen in the virus hemagglutination test (*5*).

Successful coupling of penicillin to erythrocytes has been accomplished with penicillins T (*p*-aminobenzyl penicillin) and V (phenoxymethyl penicillin). Rabbit, sheep, or human group O, Rh-negative erythrocytes may be used. If erythrocytes of heterologous species are employed, absorption procedures are carried out to eliminate nonspecific agglutination. After preliminary experiments, the human red cell was selected as a matter of convenience.

It is essential to determine the optimal ratio of BDB to penicillin for the sensitization of the erythrocytes. This is accomplished by a "checkerboard" titration of a known positive antipenicillin serum and a negative serum with (i) erythrocytes exposed to a constant amount of penicillin and varying volumes of a 15-fold dilution of BDB and (ii) erythrocytes exposed to varying amounts of penicillin and a constant volume of the diluted BDB. That combination of the two reagents producing the highest titer with the positive serum and no reactions with the negative serum and in the controls is used for the performance of the test proper.

The sensitized erythrocytes are washed once in 1-percent normal rabbit serum in a phosphate buffer of *p*H 7.3 (NRS 1:100). The same medium (NRS 1:100) has to be used to prepare the 2-percent erythrocyte suspension, as the sensitized cells are unstable in saline. For the same reason NRS 1:100 is also used to prepare the twofold dilutions of the test sera.

Table 1. Hemagglutination* titers of sera from penicillin-sensitive subjects.

| Patient's serum | Serum dilutions (in NRS 1:100) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1:4 | 1:8 | 1:16 | 1:32 | 1:64 | 1:128 | 1:256 |
| JH-2 | 4+ | 4+ | 4+ | 4+ | 3+ | ± | 0 |
| DMP-2 | 4+ | 3+ | 2+ | ± | 0 | 0 | 0 |
| BV-1 | 2+ | 2+ | 2+ | 0 | 0 | 0 | 0 |
| AV-2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

* Erythrocytes sensitized with penicillin T by means of BDB.

The reaction between the serum and the sensitized erythrocytes is allowed to take place at room temperature. The results of the hemagglutination may be read in 3 to 5 hours, and observation may be repeated after overnight incubation on the bench.

Nine of 20 sera from persons with reported allergic manifestations to penicillin have produced positive hemagglutination reactions with titers from 1:4 to 1:64. Representative titrations are shown in Table 1.

Hemagglutination-inhibition experiments with decreasing concentrations of penicillin solutions and a constant dilution of a serum known to produce a 4+ reaction indicate that this technique is highly specific and sensitive. Eight units of penicillin V and four units of penicillins G and T completely prevented agglutination of erythrocytes linked to penicillin T. Moreover, the cross reactions exhibited by the hemagglutination-inhibition test appear to lend support to the assumption that the penicillin molecule per se, rather than the side chain, is primarily concerned in eliciting antibody formation.

The clinical significance of the antibody to penicillin is being investigated (*6*).

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### References and Notes

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2. A. B. Ley *et al.*, *Science* **127**, 1118 (1958).
3. K. C. Watson, S. M. Joubert, M. A. E. Bennett, *Nature* **183**, 468 (1959).
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5. J. E. Salk, *J. Immunol.* **49**, 87 (1944).
6. I wish to thank A. L. Tosoni, Connaught Medical Research Laboratories, University of Toronto, for the penicillin T and C. W. Pettinga, Eli Lilly and Company, Indianapolis, Ind., for the penicillin V used in this work. Thanks and appreciation are extended to G. Dempster, professor and head of the department of bacteriology, College of Medicine, University of Saskatchewan, Saskatoon, for suggestions and help in this investigation.

17 July 1959

## Field of Doctorate Specialization as a Function of Size of High-School Graduating Class

In the course of an intensive study of the science doctorates of 1957 and 1958, an interesting relationship was observed between size of graduating class in high school and field of doctorate specialization. The science doctorates were grouped into three broad classifications: physical sciences (including mathematics, physics, chemistry, geology, and engineering); biological sciences (including, along with other biology fields, agriculture, biochemistry, biophysics, and research degrees in the medical sciences); and behavioral sciences (all fields of psychology and anthropology). Those scientists who had graduated from public high schools in the United States were then classified by size of high-school graduating class. The numbers of individuals by class size in public high schools, and by major field, are shown in Table 1.

It is clear that the percentage of physical-science specialists goes up with class size, that the percentage for the biological sciences drops precipitously, and that the percentage for the behavioral sciences climbs slowly but rather consistently. The numbers are large enough to insure that these trends are reliable.

The reasons for this differential in field of doctorate specialization are undoubtedly complex and only partially understood at this time. There is an obvious relationship between size of high school and urban concentration; small public high schools are most characteristic of agricultural regions. For this reason, the regional variations in public-high-school origins were examined. It was found that the biologists tend to come with disproportionate frequency from the agricultural regions, and the behavioral scientists, from areas of greatest urban concentration. (These two regional characterizations are negatively but imperfectly correlated.) The physical scientists, on the other hand, show far less regional variation in high-school origins. Table 2 shows the regional distributions of the public-high-school origins of scientists in these three major fields. (In numbers of individuals Tables 1 and 2 do not agree because of missing data in some cases.)

One may hypothesize that greater contact with life forms in the more rural schools leads to greater interest in the biological sciences (including agriculture) among the graduates of smaller high schools. Greater urban concentrations, on the other hand, expose people to more social problems, conflicts in cultures, and so on, and one may hypothesize that these contacts are a partially determining factor in the higher concentration of people from these areas in the behavioral sciences. The availability of science and mathematics courses prerequisite to careers in the physical sciences may be another powerful influence. Research now under way on the high-school backgrounds of these people may throw considerable light on this third factor. Meanwhile, class size and regional variations for those who received doctorates in 1959 are being checked.

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27 July 1959

Table 1. Size of public-high-school graduating class for individuals who received doctorates in three major fields.

| Major field | No. of individuals in high-school graduating class | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1–19 | | 20–39 | | 40–59 | | 60–99 | | 100–199 | | 200+ | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| Physical sciences | 170 | 42 | 355 | 48 | 269 | 50 | 376 | 51 | 646 | 51 | 1727 | 55 |
| Biological sciences | 196 | 48 | 316 | 43 | 209 | 39 | 266 | 36 | 422 | 33 | 817 | 26 |
| Behavioral sciences | 41 | 10 | 68 | 9 | 62 | 11 | 97 | 13 | 196 | 16 | 599 | 19 |
| Total | 407 | 100 | 739 | 100 | 540 | 100 | 739 | 100 | 1264 | 100 | 3143 | 100 |

Table 2. Regional distribution of public-high-school origins for individuals who received doctorates in science in 1957 and 1958.

| Geographic region | Physical sciences | | Biological sciences | | Behavioral sciences | | Total No. |
|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | |
| New England | 220 | 48 | 149 | 33 | 89 | 19 | 458 |
| Middle Atlantic | 931 | 54 | 421 | 25 | 359 | 21 | 1711 |
| East North Central | 662 | 54 | 387 | 32 | 176 | 14 | 1225 |
| West North Central | 292 | 47 | 218 | 35 | 114 | 18 | 624 |
| South Atlantic | 248 | 47 | 210 | 40 | 72 | 13 | 530 |
| East South Central | 95 | 49 | 71 | 37 | 27 | 14 | 193 |
| West South Central | 210 | 55 | 127 | 33 | 47 | 12 | 384 |
| Mountain | 130 | 50 | 102 | 40 | 26 | 10 | 258 |
| Pacific | 281 | 52 | 185 | 35 | 72 | 13 | 538 |
| Foreign | 666 | 54 | 474 | 38 | 97 | 8 | 1237 |
| Total | 3735 | 52 | 2344 | 33 | 1079 | 15 | 7158 |

## Enzymatic Factors in Experimental Galactose Cataract

*Abstract.* In the rat lens, glucose-6-phosphate dehydrogenase activity is specifically inhibited by galactose-1-phosphate, both in vitro and in vivo. In galactose-fed animals this inhibition occurs prior to the apparent inhibition of soluble protein synthesis in the ocular lens.

Kalckar *et al.* (*1*) have recently demonstrated a relative or absolute lack of the enzyme galactose-1-phosphate (gal-1-P) uridyl transferase in the red blood cell and liver of individuals suffering from congenital galactosemia. Similar findings were observed in the cataractous lenses removed from a galactosemic infant (*2*). Schwarz and Golberg (*3*) found that this ester accumulates in the lens capsule and epithelium of rats maintained on a 30-percent galactose diet. They noted that the concentration of gal-1-P in these lenses was approximately 10 times the amount present in the normal lenses, and that the amount of ester present in these cataractous lenses was of the same order as that found in galactosemic red cells. Since the lens is dependent on glucose as its main source of energy, an accumulation of gal-1-P in the lens may be a precipitating factor in the development of human and experimental galactose cataract.

Kinoshita (*4*) has shown that the hexose monophosphate shunt is of considerable importance in lens metabolism. In order to investigate the possibility that galactose phosphate might directly inhibit this pathway of glucose metabolism, the enzymes glucose-6-phosphate (G-6-P) and 6-phosphogluconate (6-PG) dehydrogenase were assayed in the lenses of normal and galactosemic rats.

Twelve Rochester colony white male rats, 26 days of age and weighing approximately 60 gm each, were employed. Six animals were put on a cataractogenic galactose diet (*5*), while six others were fed a control dextrose diet (*5*). As soon as the rats on the galactose diet began to show the first ophthalmoscopic evidence of cataract formation (peripheral subcapsular vac-

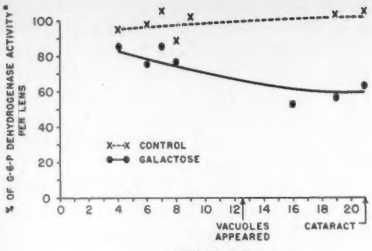


Fig. 1. Percentage of G-6-P dehydrogenase activity per lens (ordinate) as a function of days on diet (abscissa). The enzyme activity (assayed at *p*H 7.4) is expressed as $\mu$gr of $TPN^+$ reduced per hour per milligram of soluble lens protein (100 percent G-6-P dehydrogenase activity equals 21.93 units).

uolization), which occurred at the 12th to 14th day after the commencement of the galactose diet, both the control and experimental groups of animals were sacrificed. Their lenses were immediately assayed for G-6-P dehydrogenase and 6-PG dehydrogenase activities according to the method of Glock and McLean (*6*).

In the lenses derived from the experimental (galactose) animals, there was a marked inhibition of G-6-P dehydrogenase activity. The average level of activity in these animals was 13.8 units (*7*) (range 7.9 to 18.8) which was approximately 45 percent lower than the value obtained for G-6-P dehydrogenase in the control group, 25.2 units (range 23.7 to 26.9). However, the 6-PG dehydrogenase activity was essentially the same for both groups of animals. The average value in the experimental (galactose) group was 6.25 units (*7*) (range 4.71 to 9.15), while the control group showed an average of 6.16 units (range 5.10 to 7.41) of 6-PG dehydrogenase activity.

This experiment was repeated with 28 rats of the same strain and weight. Half of these animals were fed the galactose diet, while the remaining half were fed the dextrose diet. Two animals in each group were sacrificed at the 4th, 6th, 7th, and 8th days, respectively, after commencing on their respective diets. The remaining animals were sacrificed at varying periods of time, as shown in Figs. 1 and 2.

The activity of G-6-P dehydrogenase showed a significant decline at the 4th day of galactose feeding and continued to fall till the 14th day, where it leveled off at approximately 60 percent of normal, as shown in Fig. 1.

The level of 6-PG dehydrogenase showed no change in the lenses of the galactose-fed rats as compared to those of the control animals (Fig. 2).

The soluble protein fractions of all these lenses were measured by the micro-Kjeldahl method. The results are generally in agreement with Dische's findings (*8*), although the apparent inhibition of soluble protein synthesis did not occur until the 8th day of galactose feeding.

In an effort to reproduce this enzymatic inhibition in vitro, paired lenses from five normal rats were employed. Each pair of lenses was homogenized (in an ice-water bath) in 2 ml of distilled water, and the insoluble protein was removed by centrifugation. Half of each soluble protein fraction was incubated with an excess of gal-1-P to G-6-P in the media (*9*), while the remaining half was incubated with G-6-P as the sole substrate. After 3 hours of incubation at 37°C, an aliquot (0.6 ml) was removed and assayed for combined G-6-P and 6-PG dehydrogenase activities. The results of this experiment showed an average inhibition of 21 percent (range 16 to 35 percent).

Since all the aliquots contained some G-6-P, it was not possible to derive the activity of each dehydrogenase separately. This experiment was therefore repeated with four sets of paired normal lenses in which half of the incubates contained 15 $\mu$mole of gal-1-P while a similar amount of sucrose was added to the other incubates.

The results of these in vitro experiments showed that an average of 20-percent inhibition (15.6 to 34 percent) of G-6-P dehydrogenase occurred, while the 6-PG dehydrogenase activity remained unimpaired.

The foregoing experiments have demonstrated that gal-1-P is capable of specifically inhibiting G-6-P dehydrogenase in vitro and that it may act in a similar manner in vitro. This inhibition apparently occurs prior to any observed inhibition of soluble protein synthesis. An inhibition of the hexose monophosphate shunt may therefore be implicated in the pathogenesis of experimental galactose cataract. (*10*).

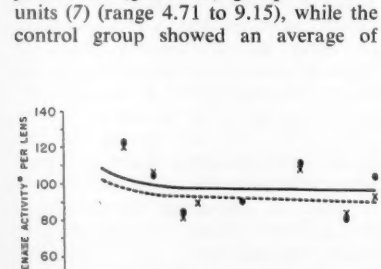


Fig. 2. 6-Phosphogluconate dehydrogenase activity per lens (ordinate) as a function of days on diet (abscissa). The enzyme activity (assayed at *p*H 7.4) is expressed as $\mu$gr of $TPN^+$ reduced per hour per milligram of soluble lens protein (100 percent 6-P-G dehydrogenase activity equals 6.9 units).

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10. This investigation was supported by research funds granted by the Rochester Eye Bank and Research Society.

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## Requirement of Bound Calcium for the Action of Surface Chemoreceptors

*Abstract.* The ability of *Hydra* to carry out the feeding reflex in response to reduced glutathione was inhibited by either (i) standing in distilled water, (ii) the presence of ethylenediamine tetraacetic acid, or (iii) the presence of magnesium ions. These three types of inhibition were reversed instantaneously by the addition of calcium ions.

Chemoreceptors are known to exist on the surface of some cnidarians, as shown by the effects of meat juice in the environment on eliciting a feeding reflex in *Hydra* (*1*) and in other species (*2*). It was not until the quantitative chemical studies of Loomis that the substance which stimulated the *Hydra* chemoreceptor was positively identified as reduced glutathione (GSH). In a lucid study Loomis demonstrated that this tripeptide is among the numerous compounds present in the fluids oozing from the wound of the prey punctured by the harpoon action of the *Hydra's* deadly nematocysts, and that GSH induces the *Hydra* to open its mouth in an attempt to swallow that prey. Loomis colorfully describes GSH as an "environmental hormone," released from a specific source—the damaged prey; passing through a fluid environment—the water between the prey and the

*Hydra*; and after stimulating a chemoreceptor, eliciting a specific response—the feeding reflex (*3*).

The existence of surface receptors which respond almost instantaneously to a specific molecule in a fluid environment of known chemical composition (*4*, *5*) seemed to be ideally suited for studies of the mechanism of chemoreception. In this report we demonstrate that GSH-receptors require the presence of calcium ions in order to function.

The feeding reflex is expressed numerically by averaging the lengths of time (in minutes) during which the mouths of all the *Hydra* tested remained open in response to GSH. Asexual *Hydra littoralis*, grown in laboratory mass cultures (*6*), were used in all the experiments. The assay consisted of the following procedure: Five *Hydra*, which had been starved for 1 day, were rinsed in 15 ml of the solution to be tested ("test solution") for 5 seconds and placed in 30 ml of fresh test solution for 1 minute. [In experiments 1*b* and 1*c* (Table 1) the *Hydra* were kept in the test solution—here, deionized water—for 35 minutes.] The *Hydra* were then placed in a spherical cavity (38 mm in diameter) of a 3- by 2-in. depression slide, and the test solution carried over with the *Hydra* was removed by means of a fine-tipped medicine dropper. To the *Hydra* were added 2 ml of the test solution containing $10^{-5}M$ GSH, freshly diluted from $10^{-3}M$ GSH. The *Hydra* were observed through a binocular dissecting microscope set at magnification 19.5. The lengths of time that the mouths of the *Hydra* remained open were recorded, and the average was taken.

The data are presented in Table 1. As shown in experiment 1*a*, the *Hydra* placed in deionized water for 1 minute opened their mouths for periods lasting over 20 minutes in the presence of GSH. However, after being placed for 35 minutes in deionized water prior to the addition of GSH, they lost some of their ability to respond (experiment 1*b*); otherwise, the *Hydra* appeared to be normal. These experiments suggested that some compound, which was perhaps bound to the surface of the cells, slowly dissociated from the membrane when the animals were kept in deionized water. Since calcium is known to be required in the *Hydra's* fluid environment for normal growth (*4*), and for many processes of excitable tissues (*7*, *8*), experiments were carried out in order to determine whether calcium is involved in the GSH-induced feeding reflex. Experiment 1*c* demonstrates that the addition of $10^{-3}M$ $CaCl_2$ to the *Hydra* which had been standing in deionized water for 35 minutes restored their ability to respond to GSH.

Table 1. Requirement of calcium for the action of GSH-receptors of *Hydra*. In addition to the ions dissolved in the different test solutions, $10^{-5}M$ GSH was present in all solutions after the 1-minute (or 35-minute) incubation periods (see text). The *Hydra* usually opened their mouths within 30 seconds after the GSH was added; the only exception was in experiment 1*b*, when the *Hydra* took about 5 minutes to open their mouths. The *p*H in experiments 1*a*, 1*b*, and 1*c* was around 5.5, and in the other experiments, around 7.8.

| Expt. No. | Test solution (time in water in parentheses) | Average time *Hydra's* mouth was open (minutes) |
|---|---|---|
| 1a | Deionized water (1′) | 23.6 |
| 1b | Deionized water (35′) | 12.7 |
| 1c | Deionized water (35′); $10^{-3}M$ $CaCl_2$(1′) | 27.2 |
| 1d | $10^{-4}M$ $NaHCO_3$ | 22.2 |
| 2a | $1.34 \times 10^{-5}M$ EDTA + $10^{-5}M$ $NaHCO_3$ | 0.0 |
| 2b | $1.34 \times 10^{-5}M$ EDTA + $10^{-5}M$ $NaHCO_3$ + $10^{-3}M$ $CaCl_2$ | 28.5 |
| 3 | $1.34 \times 10^{-5}M$ EDTA + $10^{-5}M$ $NaHCO_3$ + $10^{-3}M$ $SrCl_2$ | 6.8 |
| 4a | $10^{-5}M$ $CaCl_2$ + $10^{-4}M$ $NaHCO_3$ | 21.2 |
| 4b | $10^{-5}M$ $CaCl_2$ + $10^{-4}M$ $NaHCO_3$ + $10^{-3}M$ $MgCl_2$ | 1.4 |
| 4c | $10^{-3}M$ $CaCl_2$ + $10^{-4}M$ $NaHCO_3$ + $10^{-3}M$ $MgCl_2$ | 23.9 |

More conclusive experiments demonstrating the involvement of calcium in eliciting the feeding reflex were carried out with disodium ethylenediamine tetraacetic acid (EDTA). This chelating agent binds calcium as well as other metallic ions. As shown in experiment 2*a*, after 1 minute of exposure to EDTA, the *Hydra* lost completely their ability to carry out the feeding reflex. This inhibition was reversed in a correspondingly instantaneous manner by the addition of $10^{-3}M$ $CaCl_2$ (experiment 2*b*), the *Hydra* responding maximally (see experiment 1*c*). In all the experiments involving EDTA, $10^{-3}M$ $NaHCO_3$ was added to keep the solutions at a slightly alkaline *p*H. The addition of $NaHCO_3$ alone to deionized water (experiment 1*d*) did not significantly affect the response of the *Hydra*, as compared to their response in the slightly acid deionized water (experiment 1*a*). In addition, experiment 2*a* also demonstrates that sodium ions, recently shown to be required in the *Hydra's* fluid environment for normal growth (*5*), would not replace calcium. Similarly, sodium chloride also did not replace calcium chloride.

Other metals were tested for their ability to reverse the EDTA inhibition of the feeding reflex. The chlorides of barium, magnesium, cadmium, potassium, lithium, rubidium, and cesium were without effect. Strontium, known to be chemically very similar to calcium, partially replaced calcium in effecting the GSH-induced feeding reflex (experiment 3).

Magnesium ions are well known for their anesthetic properties (*7*). The term *anesthesia* is used here to signify "a reversible loss of the power to respond to a stimulus," according to a definition by Heilbrunn (*7*). Since calcium has been reported to reverse the effects of magnesium anesthesia (*7*, *8*), it seemed of interest to carry out the opposite experiment—that is, the inhibition of a response requiring calcium, the feeding reflex, by the addition of magnesium. As shown in experiment 4*b*, the presence of $10^{-3}M$ $MgCl_2$ in the test solution containing $10^{-5}M$ $CaCl_2$ decreased the activity of the feeding response to about 1/15 of the activity shown in experiment 4*a*. This magnesium anesthesia was reversed by increasing the calcium concentration to $10^{-3}M$ (experiment 4*c*). Thus, in these experiments, magnesium ions seem to produce their anesthetic effect by competing with calcium ions for some common sites on the *Hydra*.

Calcium is also required for the response of another receptor of the *Hydra*—the cnidoblast (*9*). This cell contains the explosive coiled nematocyst, which is discharged when the cnidoblast is stimulated by some tactile or tactile-chemical agent. We have found that these receptors respond to calcium, EDTA, and magnesium much as the GSH-receptors do. The ability of GSH to induce a feeding reflex has been demonstrated in the marine hydroids *Physalia* and *Campanularia* (*10*). Calcium is also known to be required for the action of another receptor—the stretch receptor of the crayfish (*11*), and for the action of another excitatory compound—adrenocorticotrophic hormone (*12*).

Calcium is known to have many effects on excitable tissue (*7*, *8*). For example, calcium has been reported to be involved in cell irritability, cell permeability, nerve action, and muscle contraction. The role of calcium in bioelectric events in nerve and muscle has recently been reviewed by Shanes (*13*). The mechanism of action of calcium in the GSH-receptor of *Hydra* has not as yet been determined.

The GSH-receptor of the *Hydra* is highly amenable to studies concerning the action of calcium ions on chemoreceptors. The response is to a specific molecule (GSH), it is nearly instantaneous, and it can be accurately measured by visual observation. In addition,

the fluid environment bathing the receptor can be precisely controlled experimentally and is not complicated by the presence of the many "antagonistic" cations found in Ringer's solution, sea water, or extracellular body fluids. Furthermore, since this fluid environment is of very low ionic strength, cations in the concentrations present are without osmotic effect (*4*); therefore, the amount of calcium added to elicit the feeding response experimentally perhaps closely approximates the actual amount of calcium necessary for the natural functioning of GSH-receptors.

*Note added in proof*: In addition to the specific cation requirement reported here, anions also were found to influence the feeding reflex. The order of effectiveness of the anions in increasing the duration of the feeding reflex was: $Cl > Br > I = NO_3$. This order seemed to be the reverse of the lyotropic series.

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## Molting of Preadult Nematodes of the Genus Paratylenchus Stimulated by Root Diffusates

*Abstract.* The nonfeeding preadult larvae of the plant-parasitic nematodes, *Paratylenchus projectus* and *P. dianthus*, survive in moist soil during long periods in the absence of host plants. In water, only small percentages molt to the adult stage. In root diffusates from some but not all plants, nearly all of them molt.

The last larval or preadult stage of certain species of the genus *Paratylenchus* Micoletzky often constitutes a high percentage of the total population in Illinois field soils and in old pot cultures, even in the presence of suitable host plants. Results of recent studies (*1*) indicate that the preadults of *P. projectus* and *P. dianthus* do not feed and that they are capable of long survival in moist soil without feeding; also, that those of *P. projectus*, at least, are more tolerant of desiccation and sudden freezing than are younger stages or adults. The preadult stage of these two species and also of *P. hamatus* and two apparently undescribed species is readily distinguishable from other stages by the greatly reduced stylet and esophagus and by an accumulation of opaque granules in the region of the esophagus, yet this stage seems to have attracted little attention. Reuver (*2*) described it for *P. amblycephalus* after the study reported here was far advanced. Thorne and Allen (*3*) evidently recognized but did not describe it in *P. hamatus*, and Ferris and Bernard (*4*) commented on its abundance in *Paratylenchus* spp. in some samples from Illinois soybean and corn fields.

Table 1. Efficacy of carnation-root diffusate in inducing molting of *P. projectus* and *P. dianthus* preadults.

| Treatment | No. of molts among 125 nematodes | | | | |
|---|---|---|---|---|---|
| | 3 days | 6 days | 9 days | 12 days | 15 days |
| | *P. dianthus* | | | | |
| Control* | 1 | 1 | 2 | 2 | 2 |
| Root diffusate | 28 | 73 | 96 | 99 | 104 |
| | *P. projectus* | | | | |
| Control* | 0 | 1 | 8 | 16 | 20 |
| Root diffusate | 0 | 87 | 123 | 124 | 125 |

* Distilled water to which activated carbon (Darco G-60) was added and which was then decanted and filtered. Indistinguishable results were obtained with nontreated distilled water.

In Petri-dish cultures of host plants in agar, preadults of *P. projectus* begin the final molt within 4 or 5 days after emerging from the preceding one and at no time constitute any large percentage of the total population. In pot cultures of this same species with red clover, after 100 days the preadults constituted only 7.7 percent of the total population but increased progressively to 66 percent during the following 85 days. In many older pot cultures and field samples, the proportion of preadults has exceeded 80 percent of the population of a species. The cause of this accumulation is not known, but evidently it operates either by preventing the final molt or by failing to provide the stimulus necessary to initiate it.

Working with preadults of *P. projectus* from field collections and old pot cultures and of *P. dianthus* chiefly from a jar of soil that had been stored moist for over 2 years until all other nematodes were dead, we found that preadults do not molt readily in water but that they are stimulated to molt by some substance or substances that diffuse from roots immersed in water. Leachate from actively growing pot cultures frequently, but not consistently, induces molting.

Consistently effective root diffusate was obtained by immersing the roots of heavily rooted White Sims carnation cuttings in 50 ml of distilled water for 72 hours, with 12 hours of artificial illumination each day. Table 1 presents results of a representative experiment in which preadults, in five lots of 25 each, were placed into small Syracuse dishes containing about 1 ml of carnation-root diffusate, or of water for the controls, and were held at 23° to 26°C in the dark. Fluids were changed at 3-day intervals, diffusate that had been stored at about 7°C being used. Nematodes in which the adult form and size of stylet had developed were counted as having molted.

In a temperature experiment with *P. projectus* no molting occurred at 5°, 10°, or 35°C in carnation-root diffusate or in water during 16 days. The numbers of those that molted among 125 nematodes in diffusate and 125 in water, respectively, were as follows, at four intermediate temperatures: at 15°C, 43 and 0; at 19°C, 124 and 9; at 26°C, 124 and 23; and at 30°C, 125 and 8. Molting occurred at a much more rapid rate at 26° and 30°C than at 15° and 19°C, and more rapidly in diffusate than in water at the two higher temperatures.

Seedlings of nine species of dicotyledonous plants, representing seven families, grown in sand and fertilized with an N-P-K fertilizer (Hyponex), produced root diffusates that markedly increased molting of one or both nematode species. Nine other plant species, six of them monocots, produced diffusates that were without effect on either nematode in a single test, and six additional plant species produced diffusates that were no more than slightly active. There was an imperfect agreement between suitability of plants as hosts and their production of active root diffusate. For example, *Trifolium pratense* L. (Kenland red clover) is a suitable host for both nematodes, yet in repeated tests it has yielded root diffusates that induce molting in *P. projectus* but not in *P. dianthus*.

The activity of certain root diffusates in stimulating hatching or emergence of larvae from cysts of *Heterodera* spp. is a well-known phenomenon, but we are not aware of any prior demonstration that root diffusates may stimulate the molting of plant-parasitic nematodes.

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## Growth of Tobacco Mosaic Virus Particles


*Abstract.* Past studies have characterized the structure of tobacco mosaic virus particles by a variety of methods. In the present report the screw dislocation theory of crystal growth is applied to the formation of tobacco mosaic virus particles. The growth mechanism is shown to account for the rodlike morphology. It is also deduced that the biosynthetic process occurs at the growth step at the end of a particle.


The screw dislocation mechanism of crystal growth (*1*) has been proposed to account for gross discrepancies between observed and theoretically estimated growth rates. Since the inception of the dislocation theory of crystal growth, much activity has been stimulated in studies of growth phenomena, and understanding of these phenomena has been advanced markedly.

It is of interest to indicate the main features of the dislocation growth mechanism and to relate these to an important problem, the growth of tobacco mosaic virus particles. A crystal which is bounded by close-packed crystallographic planes can only grow by the addition of new atoms or molecules to steps at the edge of crystal layers partially covering the face. When a particle layer totally covers the surface, the bounding step grows out of existence and growth ceases. Growth can only continue through nucleation of a new patch of crystal plane. Nucleation will occur at an appreciable rate when the supersaturation exceeds a critical value. Thus, a close-packed face will not advance in slightly supersaturated solutions but will only grow above a critical supersaturation.

It has been pointed out that a permanent step exists (*1*) on a close-packed surface at which a screw dislocation terminates. The step extends from the dislocation to an edge or to a dislocation of opposite hand intersecting the same surface and may advance at low supersaturations. Unlike the edge of a partial layer, the step associated with a screw dislocation never grows out of existence, and the dislocated surface will grow at very low supersaturations.

If a crystal is formed which bears a screw dislocation or dislocations in a single direction, growth at low supersaturations (*2*) can only proceed in the direction of the screw axis. Such crystals have been grown of a variety of materials. They are thin rods of constant cross section and are called crystalline whiskers. The relevance of the preceding discussion to the growth of tobacco mosaic virus is immediate, because tobacco mosaic virus particles grow as crystalline whiskers.

Tobacco mosaic virus particles have a rodlike structure consisting of a thick-walled tube of protein surrounding a core of nucleic acid. The present discussion is concerned with the growth mechanism of the outer protein tube. Experiments on solution and reprecipitation of tobacco mosaic virus protein (*3*) demonstrate that the tubular habit is independent of the presence or absence of the nucleic acid core. X-ray diffraction (*4*) studies reveal that the tube walls are made up of structurally equivalent elements arranged on a helix having a pitch of 23 A. It has been estimated that there are $3n + 1$ elements in three helical turns where $n \sim 12$. The outer cylinder diameter is 150 A, and the inner diameter is 51 A.

The protein cylinder can be dissolved in water in the sense that native tobacco mosaic virus protein or elementary structural units are the solute molecules. The protein may be recrystallized at a *p*H of about 5 to form hollow cylinders, of varying length but arranged in a helical structure. At a *p*H of 6, cylinders do not form, but tiny washers do.

In the tubular form, 12⅓ structural elements are arranged on each turn of a spiral. Twelve elements enclose 350° of a circle, as shown in Fig. 1 (top). Either of two configurations might occur: The ring might deform in its own plane and form a bond (Fig. 1, middle) between elements *A* and *B*, or the ring might be elastically deformed into a lock washer (Fig. 1, bottom) so that addition of new structural elements could occur at either end of the lock washer, as shown in Fig. 2. As each element was added, its edge could serve as a further add-on site. The configuration of Fig. 2 corresponds to a crystal with a screw dislocation in which the unit cells are the structural elements. This growth behavior corresponds to that of a crystalline whisker.

A necessary condition for the operation of the growth mechanism is that the screw-dislocated configuration must be accessible to thermal fluctuations. The preceding condition may be written

$$E_s \leqq 20\ kT \qquad (1)$$

The strain energy $E_s$ of an elastically deformed lock washer displaced by a distance $\tau$ is given (*5*) by

$$E_s = \frac{\mu \tau^2 b}{4\pi}\left[\ln \frac{r_1}{r_0} - 1\right] \qquad (2)$$

where $\mu$ is the elastic modulus, $b$ is the thickness of the washer, and $r_1$ and $r_0$ are the inner and outer radii, respectively. Substituting the numerical values $b = 2.3 \times 10^{-7}$ cm, $\tau = 2.3 \times 10^{-7}$ cm, $r_1 = 7.5 \times 10^{-7}$ cm, and $r_0 = 2.5 \times 10^{-7}$ cm, the pertinent elastic modulus

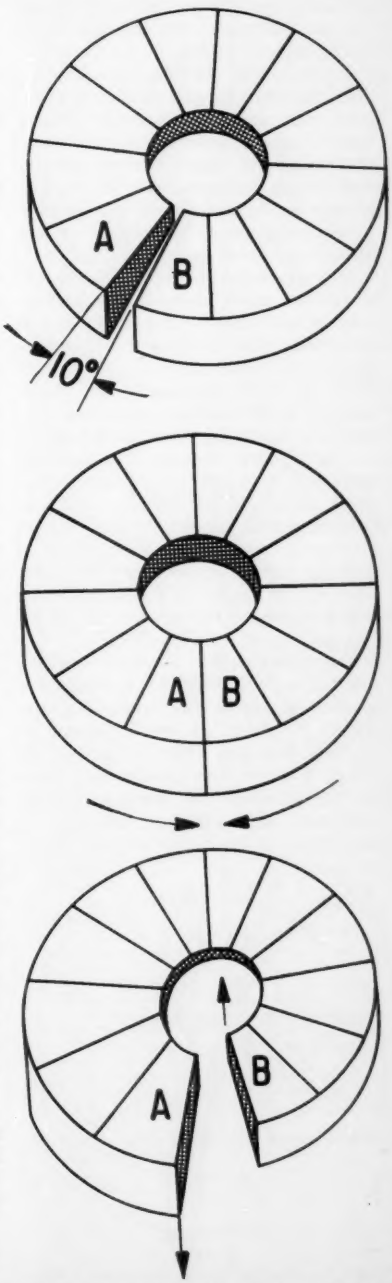


Fig. 1. (Top) Unstrained washer. (Middle) Ring with edge dislocation. (Bottom) Ring with screw dislocation.

$\mu$ can be estimated from Eq. 1 and 2. It is found that $\mu \gtrsim 10^{10}$ dyne/cm$^2$, which is a reasonable limit for a protein crystal.

When a structural element adds to the lock washer, as in Fig. 2, the configuration is stabilized by the amount of the binding energy. The stability continues to increase significantly until the length of the rod approximates the rod diameter. In the presence of the nucleic acid core, the stability would be further increased.

Qualitatively, the binding energy at the edges must be sufficient to give the screw-dislocated configuration a sufficient life-time to stabilize itself by further growth. Since the crystal ring with an edge dislocation offers no easy growth mechanism, it is only temporarily stable at a *p*H of 5, where tobacco mosaic virus rods grow.

If it is postulated that the dimensions of the structural elements are a function of *p*H, the formation of closed disks at a *p*H of 6 becomes understandable. If the closure gap in a single ring (Fig. 1, top) decreased, the elastic energy of forming an edge-dislocated structure would decrease as the square of the closure distance. As the gap decreased in width, or the circumferential dimension of the structural element increased, the strain energy would become unimportant with respect to bonding energy at the edges. The lifetime of the edge-dislocated structure would become very long, and almost all crystals should form as disks.

The characteristic rodlike morphology becomes a necessary consequence of the physical laws governing the growth behavior. It is of interest to proceed one step further—that is, to obtain a reasonable model by which the reproduction of tobacco mosaic virus rods in living plant cells can be accounted for by purely physical laws.

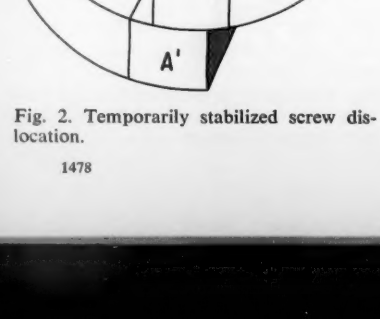


Fig. 2. Temporarily stabilized screw dislocation.

It is emphasized that this model is based on a simple and reasonable hypothesis, but that direct evidence as to its validity is unavailable.

It is well known that chemical reactions may either proceed heterogeneously or homogeneously. Recent studies of whisker growth (*6*, *7*) have further clarified the role of surface structures in chemical reactions. It has been shown that aluminum oxide (*7*) can form from the reaction of water and a suboxide on a perfect surface of an alumina crystal but not in the vapor phase. On the other hand, copper (*6*) can form from the hydrogen reduction of cuprous iodide only at growth steps on a copper surface. It seems a fair extrapolation to suggest that in many organic reactions a preferential yield of a desired product may be obtained only in the presence of the crystalline product phase.

To account for the synthesis of tobacco mosaic virus in plant tissue, it is postulated that native tobacco mosaic virus elements are synthesized from simpler molecules only at the growth steps of the original rods. If the new structural units are synthesized faster than the core is built in, the solution becomes saturated with respect to the unstabilized tobacco mosaic virus rod phase. Since this solution would be supersaturated with respect to nucleic acid-stabilized rods, it is proposed that nucleation of new stabilized rods could occur at the available supersaturation.

Since tobacco mosaic virus particles are only synthesized in plant cells in the presence of infecting particles, it must be concluded that the structural elements are not synthesized homogeneously in the cell solution. The reproduction process must involve nucleation. Nucleation requires a finite critical supersaturation of the cell solution with respect to nucleating phase. The production of the critically supersaturated solution must be thermodynamically possible. Kinetically this reaction only occurs in the presence of infecting particles. Thus, it does not occur homogeneously.

A detailed mechanism (*8*) has been described for the growth of tobacco mosaic virus particles involving the screw dislocation growth mechanism. A reasonable mechanism has been offered to account for the reproduction of tobacco mosaic virus particles in living plant cells. These mechanisms are based on the physical chemical behavior of strictly nonliving substances.

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16 April 1959

## Induced Synthesis of Liver Microsomal Enzymes Which Metabolize Foreign Compounds

*Abstract.* The administration of 3,4-benzpyrene to rats markedly increases the activities of certain liver microsomal enzymes which metabolize foreign compounds. Evidence based on studies of enzyme induction is presented which suggests the presence in liver microsomes of several enzymes which can catalyze the same type of reaction.

Previous studies have shown that a variety of polycyclic aromatic hydrocarbons induce the synthesis of certain liver microsomal enzymes by a mechanism not involving the adrenal gland, the pituitary gland, or the hormone testosterone (*1*,*2*). For instance, the intraperitoneal injection of rats with 3,4-benzpyrene (BP), 3-methylcholanthrene (MC), or 1,2,5,6-dibenzanthracene (DBA) induces marked increases within 24 hours in the activities of the hepatic microsomal enzymes which reduce the azo linkage and N-demethylate aminoazo dyes (*1*), hydroxylate 3,4-benzpyrene (*2*), or N-2-fluorenylacetamide (*3*) and conjugate *o*-aminophenol as the glucuronide (*4*). These increases in enzyme activity are paralleled by marked increases in total liver protein (*1*). The purpose of the study reported here (*5*) was to determine the effect of 3,4-benzpyrene on various other liver microsomal enzymes which metabolize foreign compounds.

The results shown in Table 1 are typical of four similar experiments in each of which pooled livers from 10 to 30 animals were used. The intraperitoneal administration of 1 mg of BP to weanling rats resulted in increased activity of a variety of enzymes within 24 hours. The hydroxylation of 3,4-

Table 1. Effect of 3,4-benzpyrene on the metabolism of foreign compounds by liver microsomes. Holtzman rats (40 to 50 gm) were maintained on a synthetic diet high in all the known vitamins (*1*) and were injected intraperitoneally with 0.25 ml of corn oil or 1 mg of 3,4-benzpyrene in corn oil. The animals (30 in each group) were decapitated 24 hours after administration of benzpyrene. The livers were removed at a temperature of 2°C and pooled, and 33 percent liver homogenate was made in 1.15 percent potassium chloride solution. The homogenate was centrifuged, and all enzyme assays were carried out on the same 9000 *g* supernatant (20 minutes) or on washed microsomes obtained by centrifugation of the 9000 *g* supernatant for 30 minutes at 105,000 *g*. Acetanilide, naphthalene, quinoline, and 4-methoxyacetanilide metabolism were measured in a system containing microsomes, TPN, glucose-6-phosphate, and glucose-6-phosphate dehydrogenase, and the metabolism of the remaining substrates was measured with the 9000 *g* supernatant fraction fortified with glucose-6-phosphate and TPN. In all cases the formation of reduced TPN was not a rate-limiting step for the enzyme reaction. References for the enzyme assays are given in column 1 in parentheses after the name of each substrate.

| Substrate | Major product | Metabolism (μmole / gm of liver per hr)* | | Activity ratio |
|---|---|---|---|---|
| | | Control | Benz-pyrene | |
| | *Hydroxylation* | | | |
| 3,4-Benzpyrene (*2*) | Mixture of hydroxylated products | 0.42 | 5.1 | 12 |
| Acetanilide (*13*) | 4-Hydroxy-acetanilide | 0.48 | 3.1 | 6.5 |
| Zoxazolamine (*14*) | 6-Hydroxy-zoxazolamine | 1.3 | 4.9 | 3.8 |
| Chlorozoxazone (*14*) | 6-Hydroxy-chlorozoxazone | 2.2 | 3.0 | 1.4 |
| Quinoline (*13*) | 3-Hydroxy-quinoline | 0.20 | 0.41 | 2.0 |
| Naphthalene (*13*) | 1-Naphthol | 0.54 | 1.1 | 2.0 |
| | *Dihydro-diol formation* | | | |
| Naphthalene (*12*) | Naphthalene-1,2-dihydro-1,2-diol | 0.28 | 0.54 | 1.9 |
| | *N-Demethylation* | | | |
| 3-Methyl-4-monomethyl-aminoazobenzene (*1*) | 3-Methyl-4-aminoazobenzene | 1.9 | 10 | 5.3 |
| N-Methyl-aniline (*9*) | Aniline | 0.41 | 0.82 | 2.0 |
| Monomethyl-4-aminoantipyrine (*15*) | 4-Amino-antipyrine | 0.061 | 0.20 | 3.3 |
| Meperidine (*16*) | Normeperidine | 0.38 | 0.12 | 0.32 |
| Benadryl (*16*) | 2-(Benzhydryloxy)-ethylamine | 0.46 | 0.32 | 0.70 |
| | *Ether cleavage* | | | |
| 4-Methoxy-acetanilide (*13*) | 4-Hydroxy-acetanilide | 2.0 | 2.8 | 1.4 |
| | *Azo reduction* | | | |
| 4-Dimethyl-aminoazobenzene (*1*) | Aniline and N-dimethyl-*p*-phenylenediamine | 4.3 | 8.6 | 2.0 |
| | *Sulfoxide formation* | | | |
| Chlorpromazine (*17*) | Chlorpromazine sulfoxide | 0.88 | 0.84 | 0.96 |
| | *Side-chain oxidation* | | | |
| *p*-Nitrotoluene (*18*) | *p*-Nitrobenzoic acid | 0.70 | 1.12 | 1.6 |

* The amount of microsomal protein per gram of liver is not altered by treatment with BP.

benzpyrene, acetanilide, and zoxazolamine and the N-demethylation of 3-methyl-4-monomethylaminoazobenzene are increased 4- to 12-fold by treatment with BP. Smaller increases are consistently observed for the hydroxylation of naphthalene, quinoline, and chlorozoxazone, the conversion of naphthalene to its 1,2-dihydro-1,2-diol, the N-demethylation of N-methyl aniline, the O-demethylation of 4-methoxy-acetanilide, the reduction of the azo linkage of 4-dimethylaminoazobenzene, and the side-chain oxidation of *p*-nitrotoluene. The N-demethylation of monomethyl-4-aminoantipyrine was increased in only two of four experiments. The sulfoxidation of chlorpromazine and the N-demethylation of Benadryl are either not affected or are slightly decreased by treatment with BP. In contrast, meperidine demethylation is markedly decreased.

Treatment with BP or MC does not affect several enzymes that metabolize naturally occurring substrates. Thus the activities of the liver microsomal enzymes glucose-6-phosphatase, TPN-cytochrome *c* reductase, DPN-cytochrome *c* reductase, Δ-4 cortisone reductase, and the soluble enzymes phenylalanine hydroxylase and tryptophan peroxidase-oxidase are not increased at 24 hours after treatment with hydrocarbon (*6*). However, it is of considerable interest that BP, MC, and DBA have a marked effect in stimulating biosynthesis of L-ascorbic acid in the rate (*7*).

The results presented here show that BP increases the activities of several microsomal enzymes that metabolize foreign compounds but that this hydrocarbon possesses some degree of specificity since the activities of some enzymes are either not influenced or are only slightly increased. Even among reactions of the same type it is found that BP is specific in stimulating certain enzymes to a much greater extent than others. The hydroxylation of 3,4-benzpyrene and of acetanilide are markedly increased while the enzyme(s) which hydroxylate naphthalene and quinoline are affected to a lesser extent. A similar selective action of BP on different N-demethylation enzymes is also shown in Table 1. It has previously been suggested that more than one liver microsomal enzyme may catalyze the same type of reaction —that is, ether cleavage (*8*), N-dealkylation (*9–11*) and hydroxylation (*12*). The studies of enzyme induction reported here provide further evidence for the presence in liver microsomes of several different enzymes which can catalyze the same type of reaction.

A. H. Conney, James R. Gillette, Joseph K. Inscoe, Eberhard R. Trams, Herbert S. Posner*

*National Institutes of Health, Bethesda, Maryland*

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* Present address: St. Elizabeth's Hospital, Washington, D.C.

17 June 1959

# Association Affairs

## Programs Planned for the AAAS Chicago Meeting

Section and society programs in engineering, industrial science, education, and programs of general interest are given here. Programs in mathematics, physics, chemistry, astronomy, geology and geography, the biological sciences, anthropology, psychology, the social and economic sciences, the history and philosophy of science, the medical sciences, and agriculture have been previously announced [*Science* **130**, 1196, 1258, 1344, 1428 (1959)].

### Engineering

*Section M.* Four-session symposium: "National and International Aspects of Systems of Units," cosponsored by the Western Society of Engineers; arranged by a committee, Carl F. Kayan, Columbia University, chairman; 28 and 29 Dec.

Part I: "The Confusion of Chaos in Units"; Carl F. Kayan, presiding. Papers on the international viewpoint of an American engineer on units (Walker L. Cisler, American Society of Mechanical Engineers); should American industry convert to the metric system?—summary of views recently expressed by industry (G. F. Hussey, Jr., American Standards Association); our units of weights and measures (Lewis V. Judson, National Bureau of Standards); international challenge to American education and its relationship to the unit system (John J. Theobald, Superintendent of Schools, New York City); farmers and grain processors unit simplification (Hamill Varner, Quaker Oats Company); the chaos in packaging (Colston E. Warne, Consumers Union).

Part II: "Public Education vs. the Consumer Public"; H. C. Diehl, Trans-American Refrigerating Services, presiding. Papers on decimalization in the schools (James H. Smith, Board of Education, Chicago); children versus decimals and other fractions (Lore Rasmussen and David A. Page, University of Illinois); food container standardization and the public interest (Howard Stier, National Canners Association); packaging identification and marking (Allyn C. Beardsell, Mead Corporation); common fractions versus decimals in stock exchange reporting (Robert M. Bishop, New York Stock Exchange).

Part III: "Problems of Design, Manufacture, and Commerce"; Robert J. Painter, American Society for Testing Materials, presiding. Papers on linear measure decimalization in building design and construction (Perry Coke Smith, Voorhees, Walker, Smith, Smith and Haines); measuring units for the textile industry—present and prospective (Arthur D. Scroggie, E. I. duPont de Nemours & Company); English and metric systems of measurements in the forest-products industries and their effect on manufacturing and construction practices (A. J. Panshin, Michigan State University); machine tools and the inch-meter conversion (H. S. Sizer, Brown and Sharpe Manufacturing Company); weighing with decimals (R. E. Bell, Toledo Scale Corporation); pro's and con's of the weighing problem versus decimal and metric changeover (C. G. Gehringer, Fairbanks, Morse and Co.)

Part IV: "The Look to the Future"; Clarence E. Davies, United Engineering Trustees, Inc., presiding. Papers on the decimal idea in handling units (Chauncey D. Leake, Ohio State University); progress report on the changeover problems for Great Britain (T. P. Thomas, British Association Metric Committee); the adoption of a new system of weights and measures (Irvine C. Gardner, National Bureau of Standards); enforcement of the recently adopted metric system in Japan (Mitsuo Tamano, Central Inspection Institute of Weights and Measures, Tokyo); accelerated progress in the automotive decimalization program (Roy P. Trowbridge, General Motors Company); Parke-Davis adopts the metric system (Don G. Neill, Parke-Davis Company); highlights of the special AAAS report on metric usage (Wilmer Souder, AAAS Committee on Metric Usage).

Section M is a cosponsor of Section E's three-session symposium, "Great Lakes Basin"; 29 and 30 Dec. [*Science* **130**, 1197 (30 Oct. 1959)] and the two sessions of the Conference on Scientific Manpower, "Higher Education" and "Training in Emerging Fields of Science and Technology"; 28 Dec.

*Tau Beta Pi Association.* Address: "A New Order of Technological Challenge in the Nation's Space Program," T. Keith Glennan, National Aeronautics and Space Administration; Introduction by John T. Rettaliata, Illinois Institute of Technology; 27 Dec.; Donald A. Dahlstrom, Eimco Corporation, presiding.

### Industrial Science

*Section P.* Industrial Science Award dinner; 28 Dec.; Allen T. Bonnell, Drexel Institute of Technology, presiding.

Symposium: "Science Looks at the Food Industry," cosponsored by the Institute of Management Sciences; 29 Dec.; arranged by Allen T. Bonnell with Earl P. Stevenson, Arthur D. Little, Inc., presiding. Papers on the biological sciences and the food industry (Walter L. Obold, Drexel Institute of Technology); the physical sciences and the food industry (John R. Matchett, U.S. Department of Agriculture); the social sciences and the food industry (Ross Anthony Kelly, University of Illinois); the behavioral sciences and the food industry (Leonard Kent, Needham, Louis and Brorby, Inc.).

Luncheon meeting and vice presidential address: "Scientific Man and Unscientific Society," by Frank C. Croxton, Battelle Memorial Institute; 29 Dec.; Earl P. Stevenson, presiding.

*Institute of Management Sciences.* Symposium: "Management Science," cosponsored by AAAS Section P; 29 Dec.; arranged by Merrill M. Flood, University of Michigan, with Abraham Charnes, Northwestern University, presiding. Papers on the study of problem-solving in humans and computers (Allen Newell, Rand Corporation); application of information theory to the learning of artificial languages (Anatol Rapoport, University of Michigan); a use of simulation in the study of inter-nation relations (Harold Guetzkow, Northwestern University).

*Society for Industrial Microbiology.* Organizational meeting; 29 Dec.; for the formal organization of the Chicago Section. A program of invited and contributed papers is being organized to celebrate the tenth anniversary of the national society by Charles C. Yeager, Scientific Oil Compounding Company.

### Education

*Section Q.* Papers will be presented on "Organic and Social Factors in Mental Deficiency and Their Significance to the Educational Program," cosponsored by the Council for Exceptional Children; 26 Dec.; arranged by Frances A. Mullen, assistant superintendent of schools, Chicago, who will preside.

There will be a session of papers on "Weapons of the School in the War Against Delinquency," cosponsored by

the Council for Exceptional Children; 26 Dec.; arranged by Frances A. Mullen, with Ivan K. Garrison, Council on Exceptional Children, presiding.

Symposium: "How Attitudes Affect Disease Control," jointly with the National Society for Medical Research, cosponsored by the National Association of Biology Teachers; 29 Dec.; arranged by Ralph A. Rohweder, National Society for Medical Research, who will preside. Papers on attitudes that cause disease (Archie R. O'Connor, Clinton, Mich.); attitudes that block treatment (William Kaufmann, *International Archives of Allergy and Applied Immunology*); attitudes that obstruct public health measures (Robert Barr, State Board of Health, St. Paul, Minn.); attitudes that hamper medical science generally (John Hampton, Tulane University).

Vice presidential address: "Fallacies in the Concept of Over-achievement," Warren G. Findley, Board of Education, Atlanta, Ga.; 29 Dec.

There will be six sessions of contributed papers; 29 and 30 Dec. Session I: arranged by Herbert A. Smith, U.S. Office of Education, who will preside. Session II: arranged by Herbert A. Smith, with P. G. Johnson, Cornell University, presiding. Session III: arranged by Herbert A. Smith, with Clarence Boeck, University of Minnesota, presiding. Session IV: jointly with the American Educational Research Association; arranged by Warren G. Findley, with Herbert A. Smith presiding. Session V: jointly with the American Educational Research Association; arranged by Warren G. Findley, who will preside. Session VI: jointly with the American Educational Research Association; arranged by Warren G. Findley, with Chester W. Harris, University of Wisconsin, presiding.

Special session; jointly with the American Educational Research Association; 30 Dec.; arranged by Warren G. Findley, with John C. Flanagan, University of Pittsburgh, presiding. A report on the national project for the identification, development, and utilization of human talent.

### Science Teaching Societies

In the General Program, which will be sent to advance registrants by first-class mail in the first half of December, and will also be available at the meeting, the programs of the four science teaching societies which meet regularly with the AAAS will be arranged in one convenient chronological sequence. It has seemed advisable, however, to arrange them by societies here. Mrs. Muriel Beuschlein, Chicago Teachers College, has served as program coordinator, not only for the general sessions, other joint sessions, but for the individual programs of NABT, NARST, NSTA, and ANSS.

*National Association of Biology Teachers.* Session on "Space Medicine"; 27 Dec.; Paul Klinge, Indiana University, presiding. Papers on animal health and disease in the space age (Dean H. Ferris, University of Illinois); radio telemetry of nerve action potentials (Roger M. Morrell, Montreal Neurological Institute); significance of the results of the Jupiter bioflight program (Dietrich E. Beischer, U.S. Naval Aviation Medical Center).

Session on "Streamlining Biology"; 28 Dec.; H. Seymour Fowler, Pennsylvania State University, presiding. Papers on the "block of time" idea for biology instruction (Addison E. Lee, University of Texas); streamlining biology (Oswald Tippo, Yale University; H. Burr Roney, University of Houston; Arnold Grobman, University of Colorado); advanced placement biology (John F. Mehner, Senior High School, Mount Lebanon, Pa.).

Presidential address: "Biology's Bright Future," by Paul Klinge; Howard E. Weaver, University of Illinois, presiding.

Session on "Planning Biology Teaching Facilities"; 28 Dec.; Phillip R. Fordyce, Oak Park High School, Oak Park, Ill., presiding. Papers on suggestions for improving the high school biology laboratory (Steve M. Pattee, Jefferson Senior High School, Iowa); functional planning for science facilities (Basil Castaldi, University of Illinois); the development and use of school grounds as outdoor laboratories for science (Richard L. Weaver, University of Michigan); general discussion of biology teaching facilities.

Session on "Methods in Senior High School Biology"; 29 Dec.; Paul V. Webster, Bryan, Ohio, presiding. Papers on tactics and strategy in dealing with the gifted students in biology (Paul F. Brandwein, Harcourt Brace and Company); problems dealing with the growth of rats using vitamins, minerals, and hormones—a project for gifted students (Arthur J. Baker and Leonard G. Scheel, Community High School, Illinois); kids like to study snakes (Gilbert Dehne, Michigan City High School, Michigan City, Ind.).

Luncheon; 28 Dec.; arranged by Philip R. Fordyce and Howard E. Weaver with Paul Klinge presiding. Address: "Life Forms To Be Expected Elsewhere than on the Earth," by Herman J. Muller, Indiana University.

*National Association for Research in Science Teaching.* Research symposium: 28 Dec.; arranged by Vaden W. Miles, Wayne State University, and John C. Mayfield, University of Chicago, with Vaden W. Miles presiding. Papers on a review of recent research in elementary science education (Betty Lockwood Wheeler, Central Michigan University); implications of the findings of recent research in elementary science education (Paul E. Blackwood, U.S. Office of Education); review of recent research in secondary science education (Hubert Evans, Teachers College, Columbia University); implications of the findings of recent research in secondary science education (William B. Reiner, Board of Education, New York City); review of recent research in college level science education (John H. Woodburn, Johns Hopkins University); implications of the findings of recent research in college level science education (Herman R. Branson, Howard University); summary (Cyrus W. Barnes, New York University).

*National Science Teachers Association.* Three concurrent sessions: "Here's How I Teach Space Science"; 27 Dec. Session I: Elementary School Level; Helen J. Challand, National College of Education, Illinois, presiding. The speakers will be Lawrence F. Hubbell, Elementary Schools, Oak Park, Ill.; Mildred L. Ballou, Public Schools, Des Moines, Iowa; Eileen M. Nelson, National College of Education. Session II: Junior High School Level; Edward Victor, Northwestern University, presiding. The speakers will be John Sternig, Public Schools, Glencoe, Ill.; Theodore W. Wallschlaeger, Palmer School, Chicago; Donald A. Boyer, Public Schools, Winnetka, Ill.; Session III: Senior High School Level; John S. Richardson, Ohio State University, presiding. The speakers will be Murl B. Sailsbury, Evanston High School, Evanston, Ill.; Eloise A. McElfresh, Roosevelt Junior High School, Charleston, W. Va.; Nelson L. Lowry, Arlington Heights High School, Illinois.

Three-session symposium: "K-12 Planning"; 28 and 29 Dec. Part I; Robert A. Rice, Berkeley High School, Berkeley, Calif., presiding. Papers on problems and issues (Donald G. Decker, Colorado State College); what research says (Kenneth E. Anderson, University of Kansas); the critical years, grades 7–9 (Erwin L. Slesnick, University High School, Columbus, Ohio); teaching the talented (J. Ned Bryan, North Central Association); science and the technical arts (James Kendall, Oak Park-River Forest High School, Illinois); extending the program beyond normal school hours (Lester S. Hollinger, Glen Rock High School, New Jersey); earth science in the K-12 program (Loren T. Caldwell, Northern Illinois University); science in the elementary school (Robert C. Van Raalte, Department of Public Instruction, Madison, Wis.).

Part II; Round Table Discussions; Donald G. Decker, Colorado State College, coordinator. The leaders will be

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Part III; Summary of Round-Table Discussions; Donald G. Decker, presiding.

Conference on the Future Scientists of America Program; 30 Dec.; Zachariah Subarsky, Bronx High School of Science, presiding.

*American Nature Study Society*. Session on "Natural History of the Chicago Area"; 27 Dec.; Stanley B. Mulaik, University of Utah, presiding. Papers on reptiles and amphibians of the Chicago area (James A. Fowler, Cranbrook Institute of Science); plant life of the Chicago area (Floyd A. Swink, Forest Preserve District of Cook County); native grasses and ecology of the Illinois prairie (Alice Goodrich, Chicago); Chicago and the rest of the universe (Daniel Q. Posin, DePaul University); the dunes area (Terzo P. Amidie, Gary, Ind.).

Session on "Contributions of Research toward a Better Interpretation of Nature"; 28 Dec.; Emery L. Will, New York State University, College of Education, presiding. Papers on interrelationships of biological and physical sciences in ecological studies (Ted F. Andrews, Kansas State Teachers College); the naturalist and the scientist (Harlow B. Mills, Illinois State Natural History Survey); natural history research for the layman (Verne N. Rockcastle, Cornell University); importance of scientific accuracy in field studies for better nature interpretation (Howard H. Michaud, Purdue University).

Session on "Reaching the Public—Problems Ahead"; 28 Dec.; H. Raymond Gregg, National Park Service, presiding. Papers on public information program for adults (Roland F. Eisenbeis, Forest Preserve District of Cook County, Ill.); nature study in tomorrow's schools (John W. Brainerd, Springfield College); the fight for wilderness in an urban society (William J. Beecher, Chicago Academy of Science); the National Park Service prepares for the future (John E. Doerr, National Park Service); reaching America's youth through the Boy Scouts of America (E. Laurence Palmer, Ithaca, N.Y.).

Session on "Nature Writing for the Present and Future"; 29 Dec.; S. Glidden Baldwin, Danville, Ill., presiding. Papers on an author looks to the future (Robert M. McClung, Chevy Chase, Md.); writing for today's children (Dorothy M. Matala, Iowa State Teachers College); royalty, retirement, and rebellion: three R's of nature writing (E. Laurence Palmer); watching the birds with a million readers (Anne Douglas, Gary, Indiana).

Banquet; 29 Dec.; arranged by Elizabeth Blair, Barrington, Ill., with Stanley B. Mulaik, University of Utah, presiding. Address: "Adventure in Africa," by Murl Deusing, Museum of Science and Natural History.

*Joint Sessions of the Four Science Teaching Societies*. General session on "Man and Space Travel"; 27 Dec.; arranged by Robert H. Carleton, National Science Teachers Association, who will preside. Papers on surface of the moon (John A. O'Keefe, National Aeronautical and Space Administration); the place of planetaria in teaching space science (James A. Fowler, Cranbrook Institute of Science).

Elementary–Junior High School Science Assembly; 29 Dec.; J. Myron Atkin, University of Illinois, presiding. Papers on the building of science programs: kindergarten–grade 8 (Ernest Bonhivert, Glencoe Public Schools, Illinois); teaching about chemical changes (Kenneth George, Midlothian Public Schools, Illinois); teaching modern concepts in astronomy (Fred Wilkin, Highland Park Public Schools, Illinois); teaching about insects (Alvin Quinn, Lincolnwood Public Schools, Illinois).

**Programs of General Interest**

*Academy Conference*. Junior Scientists Assembly, four sessions at the Chicago Museum of Natural History; 29 and 30 Dec.; arranged by M. B. Sailsbury, Evanston Township High School, Illinois. Many selected students from the Chicago area, who are interested in science as a career, have been invited to the Assembly. The program will consist of a series of meetings on different frontiers of science with emphasis on science projects in order to assist students in choosing a project on which they may work. At each session different outstanding completed projects will be shown.

Junior Academy session; 27 Dec.; Elnore Stoldt, Jacksonville Illinois High School, presiding; H. Neil Hardy, Ohio State University, recorder. Papers on a brief review of former Junior Academy sessions (H. Neil Hardy); the Louisiana Junior Academy Project supported by the National Science Foundation (Harry J. Bennett, Louisiana State University); the Tennessee Junior Academy Program supported by the National Science Foundation (M. S. McCay, University of Chattanooga); the Young Naturalists'

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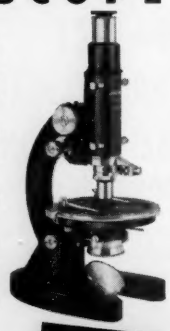

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and Young Technicians' Circles—Soviet counterpart of the Junior Academy of Science (C. Leplie Kanatzar, MacMurray College).

Business meeting and reports; 28 Dec.; A. M. Winchester, Stetson University, presiding. Papers on the do's and don'ts of applying for National Science Foundation and other grants (John A. Yarbrough, Meredith College); Academy utilization of AAAS grants over the past ten years (Clinton Baker, Southwestern at Memphis).

Panel discussion on current senior academy problems; 28 Dec.; John G. Arnold, Jr., Loyola of New Orleans, presiding. Discussion on membership—how to increase it (Kenneth B. Hobbs, Ohio Academy of Science); attendance—how to stimulate it (W. C. Oelke, Grinnel College). There will be a debate on the topic "Academies of Science should establish permanent headquarters and obtain full time executive leadership." The affirmative will be taken by Robert C. Miller (California Academy of Sciences) and Harold W. Hansen (Minnesota Academy of Science); the negative by P. H. Yancey (Alabama Academy of Science) and Wayne Taylor (Michigan Academy of Science).

Academy Conference Dinner and Presidential Address: "Tribulations of the Science Textbook Author," by A. M. Winchester, Stetson University; 28 Dec.; John A. Yarbrough, presiding.

*American Council on Women in Science.* Conference on Encouraging the Participation of Women in Science, cosponsored by Sigma Delta Epsilon; 28 Dec.; keynote speaker, Alan T. Waterman, National Science Foundation. There will be three panel workshops following Dr. Waterman's address: motivating women to select and advance in scientific careers, problems of the working woman scientist, undergraduate and graduate training for women in science.

*Conference on Scientific Communication.* Symposium: "Research in Documentation and Communication"; 29 Dec.; Joseph Gray Jackson, William Steell Jackson and Sons, presiding. Papers on semiautomatic indexing and encoding (Julius Frome, U.S. Patent Office); metallurgical document classification, storage, and retrieval (Marjorie R. Hyslop, *Metal Progress*); storing numerical values in an inverted file for mechanized information retrieval (D. D. Andrews, U.S. Patent Office); machine literature searching in science (Allen Kent, Western Reserve University).

Symposium: "International Communications in Science"; 29 Dec.; J. George Adashko, *Soviet Physics*, presiding. Papers on going abroad for translations (W. E. Sievers, National Science Foundation); who is winning the information war? (G. H. Rostky, *Electronic Design*); tracking the Russian satellite and rocket literature (I. Hersey, American Rocket Society); a combination translation and abstracting program (G. Herrmann, Columbia University).

Session on the Principles of Communication, cosponsored by Science Service; 30 Dec.; writing and science presentation by Watson Davis, Science Service.

*Conference on Scientific Manpower.* Two sessions: "Higher Education and Training in Emerging Fields of Science and Technology," cosponsored by the Engineering Manpower Commission, the Scientific Manpower Commission, the National Research Council, the National Science Foundation, and AAAS Section M–Engineering; 28 Dec. Part I; papers on engineering programs in the light of new technology (Harold L. Hazen, Massachusetts Institute of Technology); graduate training and the space sciences (John P. Hagen National Aeronautics and Space Administration); education and manpower problems in oceanography (Gordon A. Riley, Yale University).

Part II; S. B. Ingram, Bell Telephone Laboratories, presiding. Papers on implications of nuclear sciences developments for graduate training (Charles W. Shilling, Atomic Energy Commission); graduate training for metallurgy (Walter R. Hibbard, Jr., General Electric Company); graduate training requirements in chemical fuels (Richard D. Geckler, Aerojet-General Corporation).

*Honor Society of Phi Kappa Phi.* Triennial meeting; 30 and 31 Dec.

*National Association of Science Writers.* Business meeting; 28 Dec. Reception and dinner, by invitation; 27 Dec.; presentation of AAAS-Westinghouse Science Writing Awards; Pierre C. Fraley, *Philadelphia Bulletin*, presiding.

*Scientific Research Society of America.* Annual convention; 29 Dec. There will be a joint luncheon with the Society of the Sigma Xi; 29 Dec. Scientific Research Society of America address and award of the William Procter Prize will follow the luncheon.

*Sigma Delta Epsilon.* National Council and Board of Directors Meeting; 27 Dec.; Esther S. Anderson, Bureau of the Census, presiding.

Annual dinner and grand chapter meeting; 29 Dec.; Esther S. Anderson, presiding.

Luncheon for all women in science and address: "Science in Education and Education in Science," by Delaphine Rosa Wyckoff, Wellesley College; 30 Dec.; Esther S. Anderson, presiding.

*The Society of the Sigma Xi.* Sixtieth Annual Convention; 29 Dec.

Address, jointly with Phi Beta Kappa: "Adventure in Learning," by Lee A. DuBridge, California Institute of Technology; 29 Dec.

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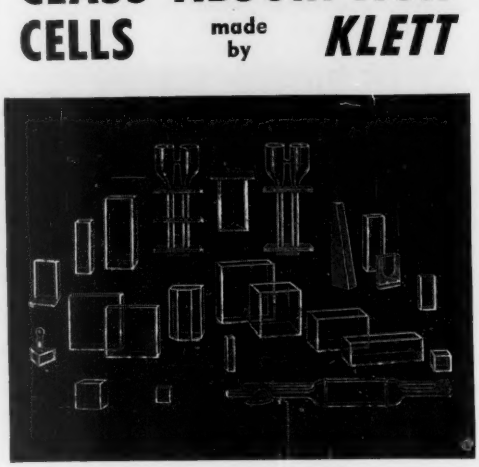

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# New Products

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■ PHOTOELECTRIC READOUT MATRICES for computer and data-processing applications feature response times the order of 10 $\mu$sec. Each matrix is made up of a multiple array of self-generating silicon cells. Typical current response is 300 $\mu$a for 0.01 in.$^2$ at 1000 lu/ft$^2$. (International Rectifier Corp., Dept. Sci230, 1521 E. Grand Ave., El Segundo, Calif.)

■ IMPEDANCE BRIDGE measures resistance from 0 to 12 megohms in eight ranges, capacitance 0 to 1200 $\mu$f in seven ranges, and inductance 0 to 1200 hy in seven ranges; dissipation factor is 0.001 to 1.000 at 1 kcy/sec; storage factor is 0.02 to 1000 at 1 kcy/sec. Corresponding accuracies in most ranges are said to be: resistance, $\pm$(0.1 percent + 1 dial division); capacitance, $\pm$(0.25 percent + 1 division); inductance, $\pm$(0.9 percent + 1 division); dissipation factor, $\pm$(5 percent + 0.0025); storage factor, $\pm$(5 percent + 0.0025). Plug-in RC networks permit selection of frequency from 100 to 10,000 cy/sec. (Rinco Inc., Dept. Sci231, 7962 E. Powell Blvd., Portland, 6, Ore.)

■ ELECTROMAGNETIC BRAKES for fractional-horsepower motors and gear trains are designed to be mounted directly on housings. Three sizes range from 1 to 2 in. in diameter with brake torques from 10 in. oz to 15 in. lb and power consumption 2 to 4 watts. Coils are available for 6, 12, 18, 28, 48, and 100 volt d-c. (Dial Products Co., Dept. Sci233, 19 Cottage St., Bayonne, N.J.)

■ POWER SUPPLY delivers 200 ma at 100 kv d-c. Operation is on 208-volt, 3 phase, 60 cy/sec power. A choke-input filter reduces output ripple to less than 0.1 percent. The high-voltage unit is contained in an oil-filled tank. The control unit, separately housed, provides motorized control of output voltage. Panel meters show kilovolts and milliamperes. (Del Electronics Corp., Dept. Sci240, 521 Homestead Ave., Mount Vernon, N.Y.)

■ SPECTROPHOTOMETER is specifically designed for measurement of hemoglobin concentration in whole blood. Analysis time is approximately 3 min, and the result is read directly as grams of hemoglobin per 100 ml of sample. (Coleman Instruments Inc., Dept. Sci246, 42 Madison St., Maywood, Ill.)

■ TIME-CODE GENERATOR, for recording time signals in magnetic tape recording of test data, consists of a crystal-controlled oscillator and seven decades of frequency division. Eight timing signals are produced from 100,000 to 0.01 cy/sec. Each signal is coded by a different pulse width permitting mixing of signals to identify elapsed time. The generator can be controlled by external electrical signals or by contact closure. (Computer Measurements Co., Dept. Sci235, 12970 Bradley Ave., Sylmar, Calif.)

■ AUTOMATIC TITRATOR detects equivalent point by color change without electrodes. Change in the intensity of a beam of light passed through the solution cuts off titrant supply. All parts of flow-control valve in contact with the solution are of Teflon or glass. A time-delay mechanism and magnetic stirring are provided. (E. Leitz, Inc., Dept. Sci234, 468 Fourth Ave., New York, N.Y.)

■ RECORDER plots r.m.s. voltage of an a-c signal from 20 cy to 200 kcy/sec on a logarithmic scale against time or another parameter that can be made time-dependent. Input range is 0 to 40 db with sensitivity 1 mv at 0 db. The instrument is a pen-writing, servo-balancing device with interchangeable potentiometers for 20, 40, and 80 db ranges. Maximum writing speed is 20 in./sec. An accessory linear potentiometer permits conversion to d-c recording, 0 to 0.8 volt full scale. Paper speeds range from 2.5 to 75 in./min. (General Radio Co., Dept. Sci239, West Concord, Mass.)

■ CALIBRATING MACHINE for force-measuring devices is a knife-blade and lever machine said to be 99.8 percent accurate from a few ounces to 20,000 lb. Load ratios of 10, 20, 40, 75, and 100 to 1 can be arranged. A mirror and lens arrangement is used to detect balance. (W. C. Dillon & Co., Inc., Dept. Sci238, 14620 Keswick St., Van Nuys, Calif.)

■ OSCILLOSCOPE displays fast repetitive wave forms by sampling successive signals. Each sample point is delayed in phase from the preceding sample so that a different part of the signal is examined each time. The entire signal is explored by a predetermined number of samples, from 50 to 1000, which recreate the wave form on the cathode-ray tube. Resolution is 50 Mcy/sec with rise time 0.7 m$\mu$sec. Calibrated sweeps vary from 1 to 100 m$\mu$sec/cm. (Hewlett-Packard Co., Dept. Sci244, 275 Page Mill Rd., Palo Alto, Calif.)

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**Texas Christian University** has several openings in its expanding **Physics Department** starting February 1960 or September 1960. Bachelor's, master's, and doctor's degrees in physics are offered. Applicants who have or are about to receive the doctor's degree will be considered. The starting rank and salary depend upon teaching experience and research qualifications. Address inquiries to Dr. Joseph Morgan, Chairman, Department of Physics, Texas Christian University, Fort Worth, Texas. X

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**Virologist.** Masters degree with virus training and 2 years' experience. Salary $440 to $550. Also opening for **Bacteriologist** with masters degree or 1 year's experience. Salary $400 to $550. Entrance steps dependent on qualifications. For work under experience virologist in diagnostic and research activities in well-equipped State Virus Laboratory, State Board of Health, Helena, Montana. 11/13, 20, 27

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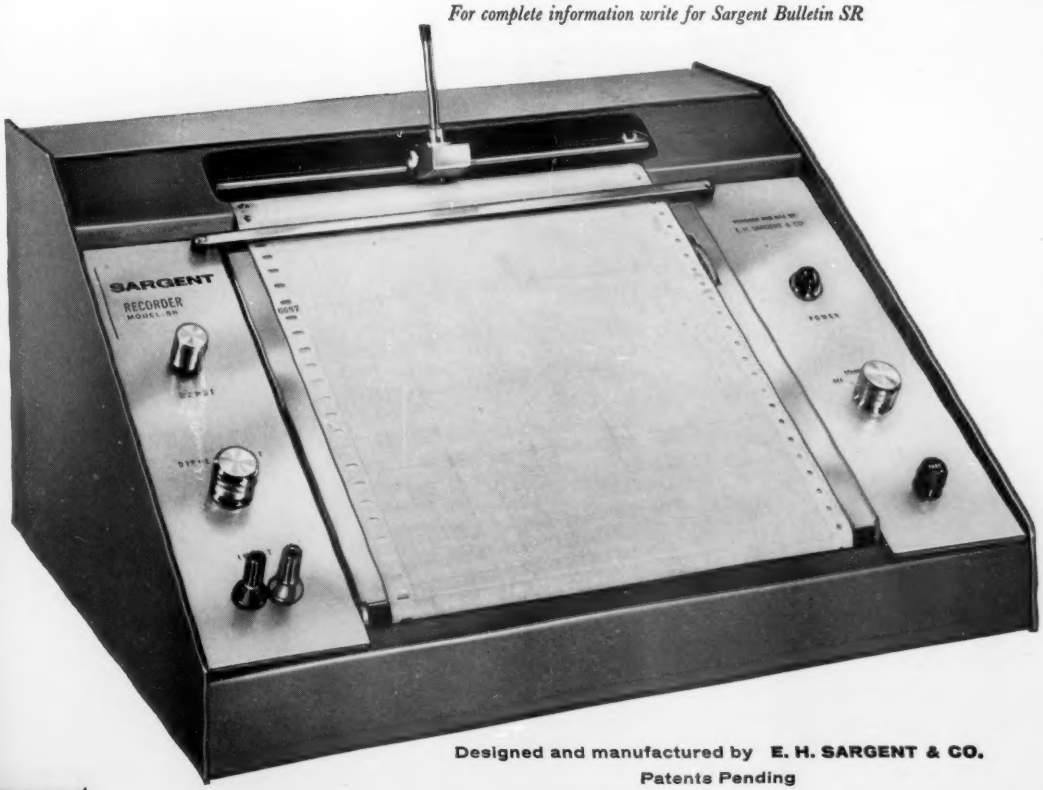


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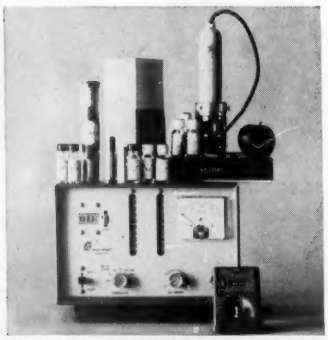

This Nuclear Training System includes a sensitive Geiger tube, a decade scaler, interval timer, sample mount and a Radionuclide Set containing eight different radioactive reagents, a micropipette, pipette syringe, and 100 stainless steel sample pans.

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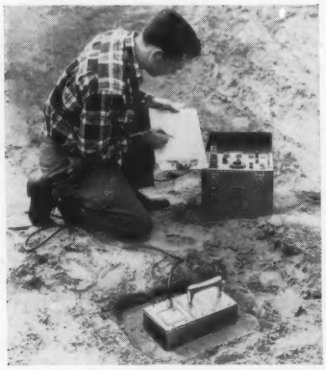
## DOWN TO EARTH

If your job requires you to dig, build on or grow things in soil, it is important that you have a



pretty good idea of its characteristics. Two of the common questions asked about soil are "What is its density?" and "What is its moisture content?". To get answers has required procedures that are time consuming, expensive and inconvenient. Now Nuclear-Chicago's d/M-Gauge® System helps get the right answers in a fast, easy, modern way.

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## RADIATION CONTROLS

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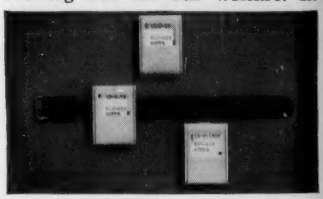

the meantime, if you have anything to do with ionizing radiation of any kind, better get a good film badge service because records are going to be valuable. We feel our service is the finest—good accuracy, accumulative reporting, ultra-fast service, low cost. Write us for full information.

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